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Part I

The main signal

- In Time Domain

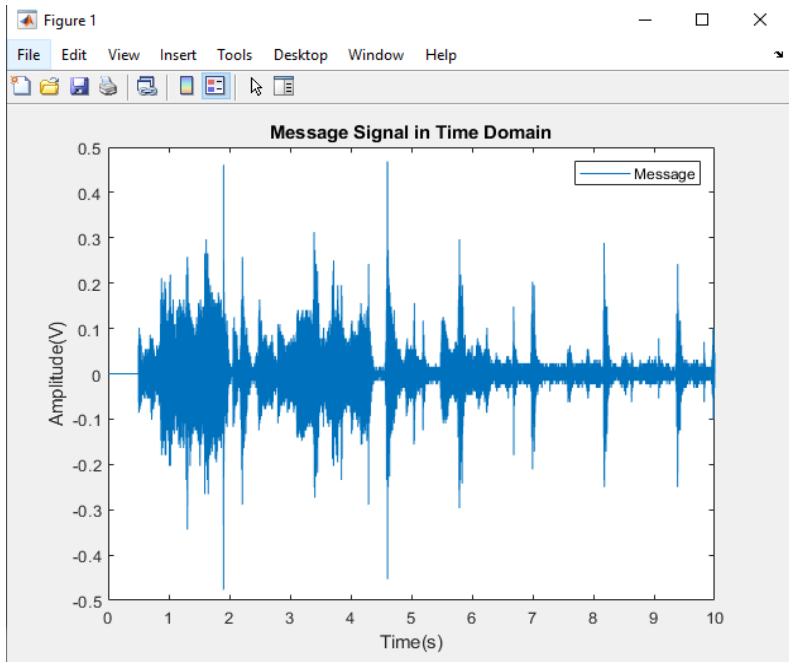

Figure 1shows the message signal in time domain

- **In Frequency Domain**

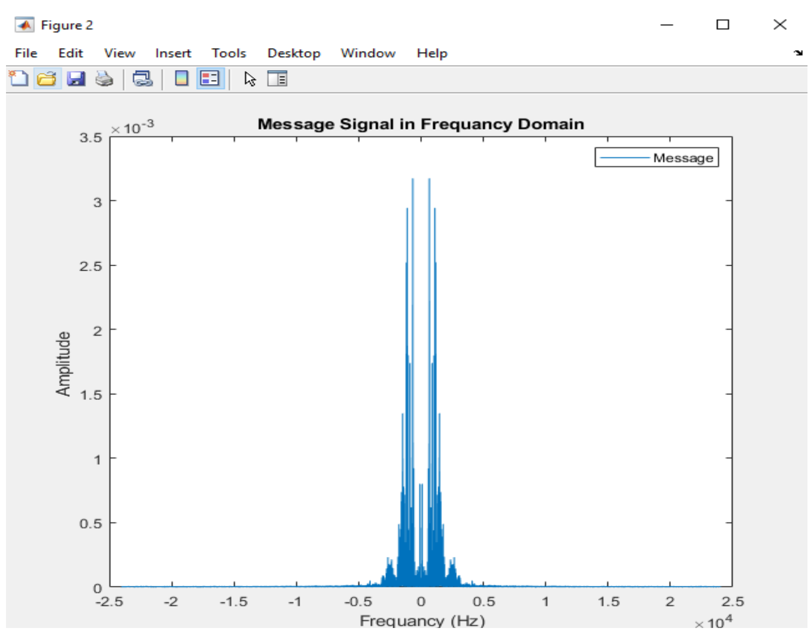

Figure 2shows the message signal in frequency domain

The Filtered Message at Fc=3.4 KHz.

- **In Time Domain**

Figure 3 shows the filtered signal in time domain

- **In Frequency Domain**

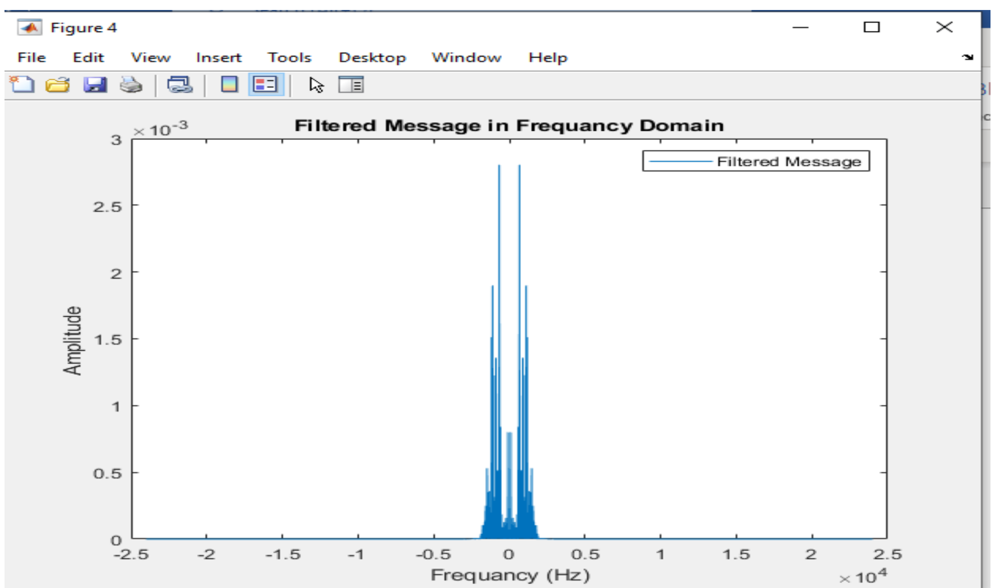

Figure 4 shows the filtered signal in frequency domain

Using filter at F cutoff =3.4 KHz, makes the signal not similar to the original. As some tones become in the transition band of the lowpass filter which makes them very low power corresponding to the low frequencies. So, part of the signal is recognizable and the other part cannot be recognized well.

The Filtered Message at Fc=700 Hz.

- In Time Domain

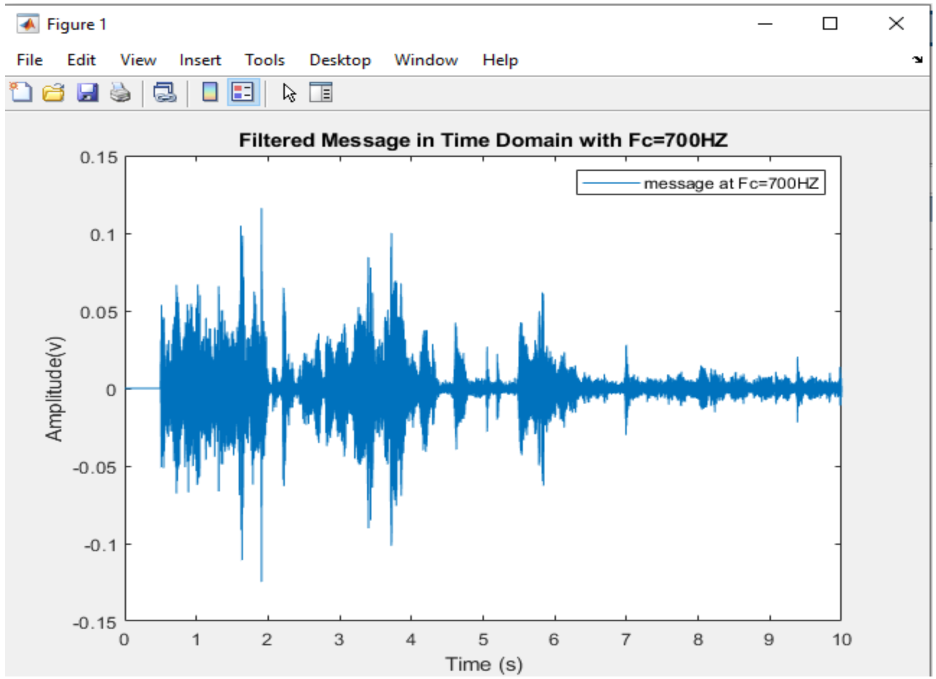

Figure 5 shows the filtered signal in time domain at fc=700Hz

- In frequency Domain

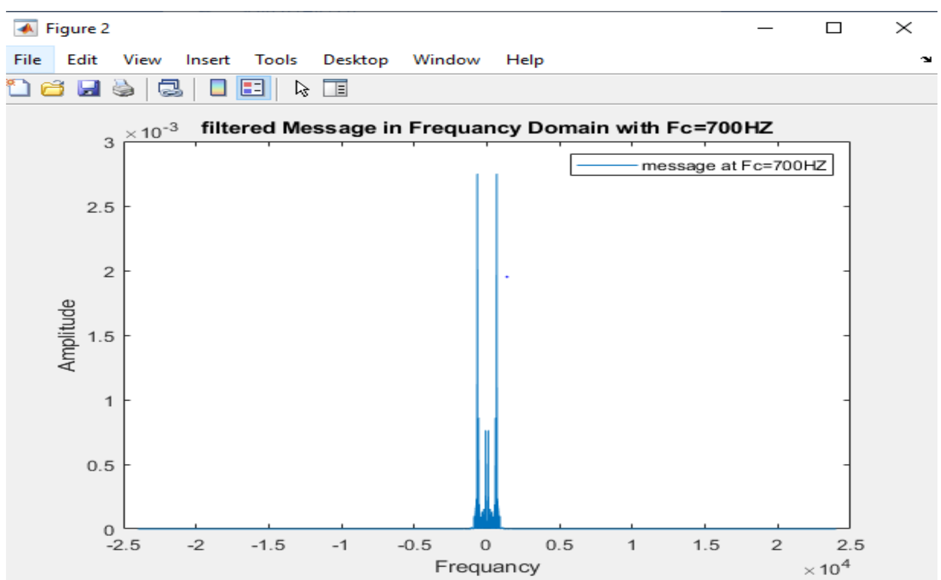

Figure 6 shows the filtered signal in frequency domain at fc=700Hz

At cutoff frequency equals 700Hz, the message becomes unintelligible. And no one could detect the sound when playing the filtered signal by using sound command.

Letter F

➢ Original In Time and frequency Domain

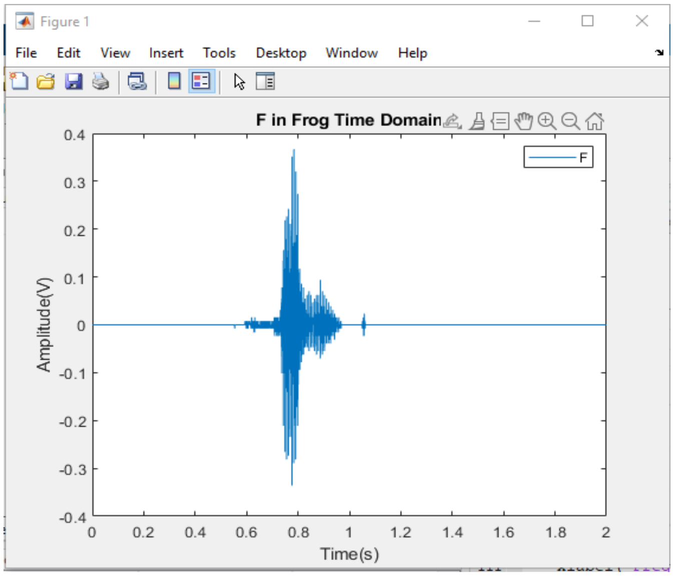

Figure 8 shows the frequency domain for letter F

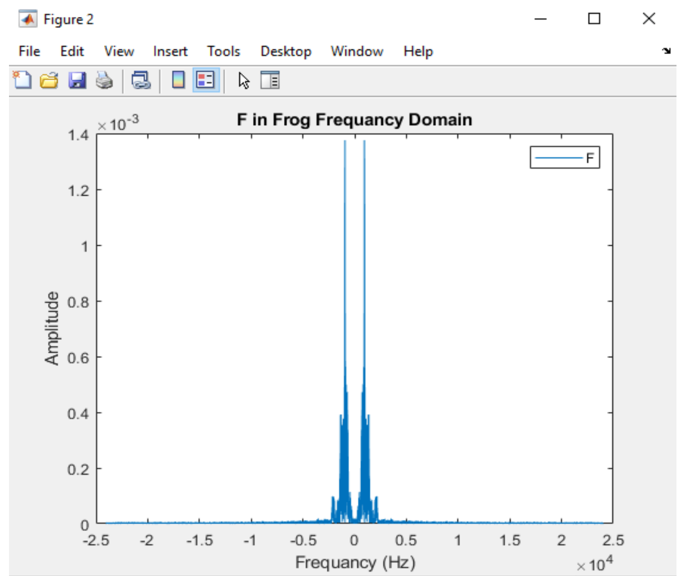

Figure 7 shows the time domain for letter F

➢ With Cutoff Frequency =1500Hz In Time and frequency Domain

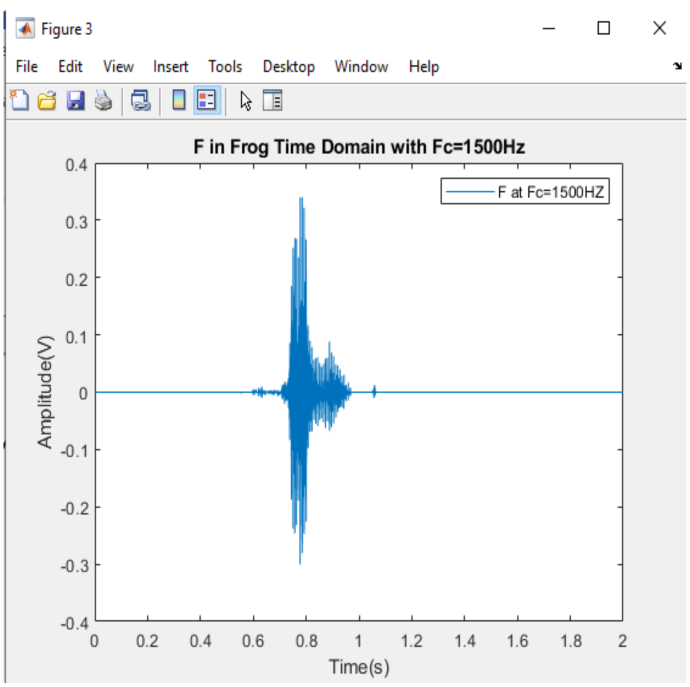

Figure 10 shows the frequency domain for letter F at fc=1500Hz

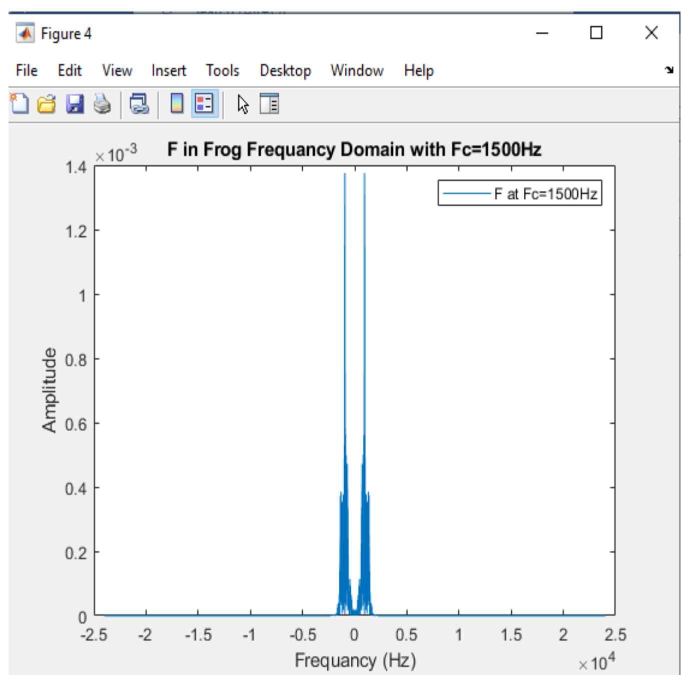

Figure 9 shows the time domain for letter F at fc=1500Hz

The letter S

- Original In Time and frequency Domain

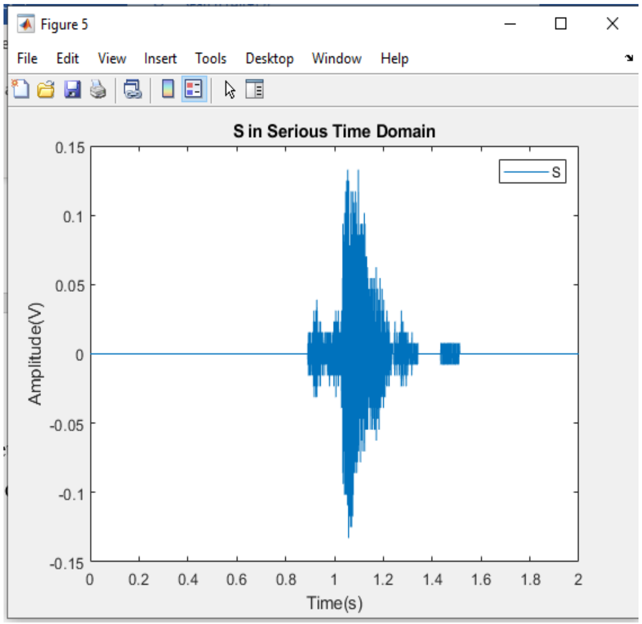

Figure 12 shows the frequency domain for letter S

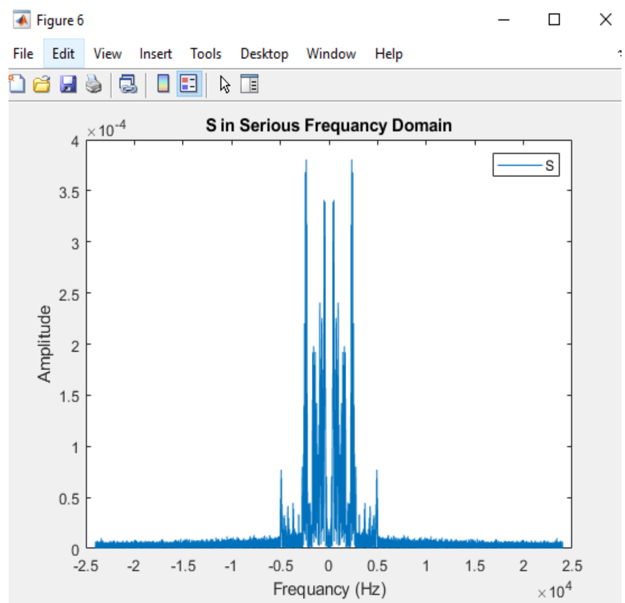

Figure 11 shows the time domain for letter S

➢

- With Cutoff Frequency =1500Hz In Time and frequency Domain

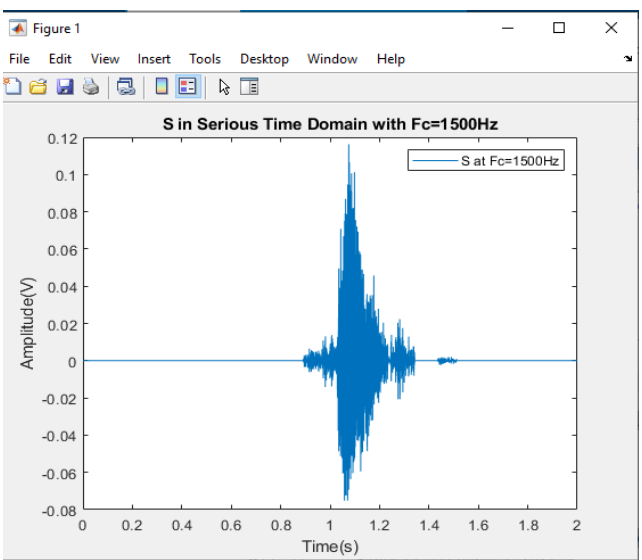

Figure 14 shows the frequency domain for letter S at fc=1500Hz

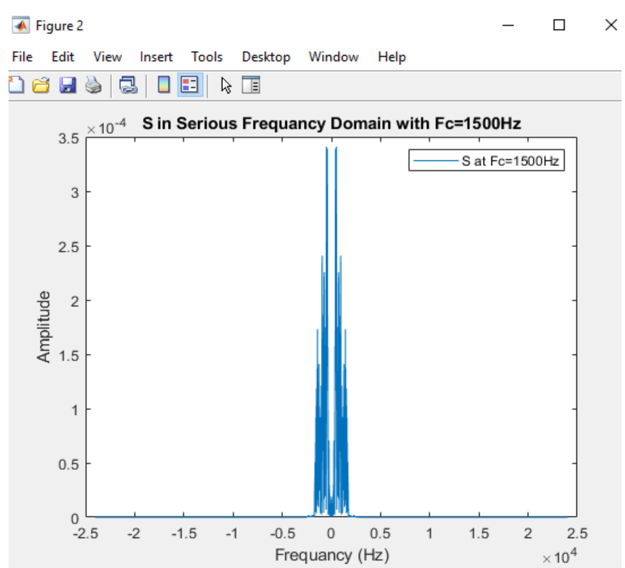

Figure 13 shows the time domain for letter S at fc=1500Hz

The letters f and s appear unrecognizable at cut off frequency= 1500 Hz. So, we can say the cut of frequency of the fricatives is about 1500 Hz.

The Letter B

➢ Original In Time and frequency Domain

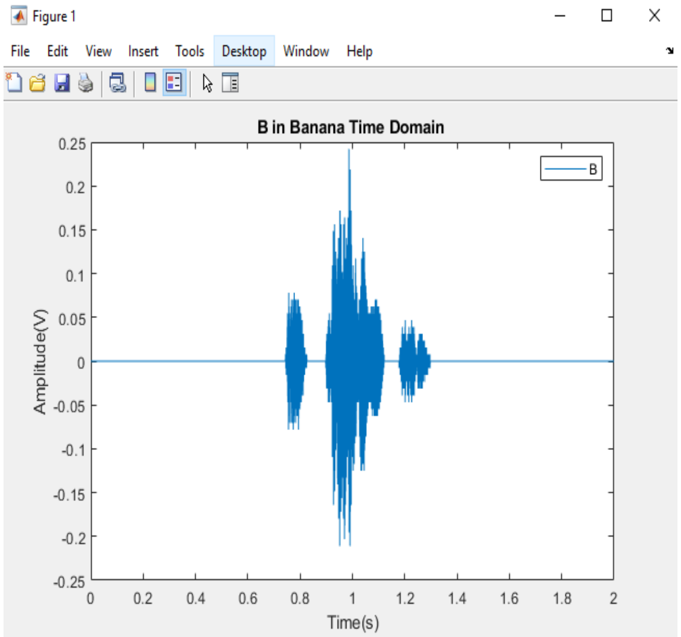

Figure 16 shows the time domain for letter B

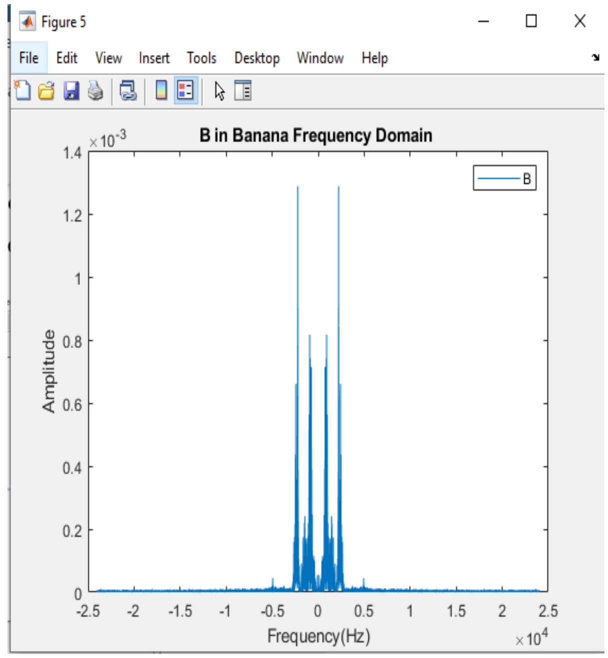

Figure 15 shows the Frequency domain for letter B

➢ With Cutoff Frequency =700Hz In Time and frequency Domain

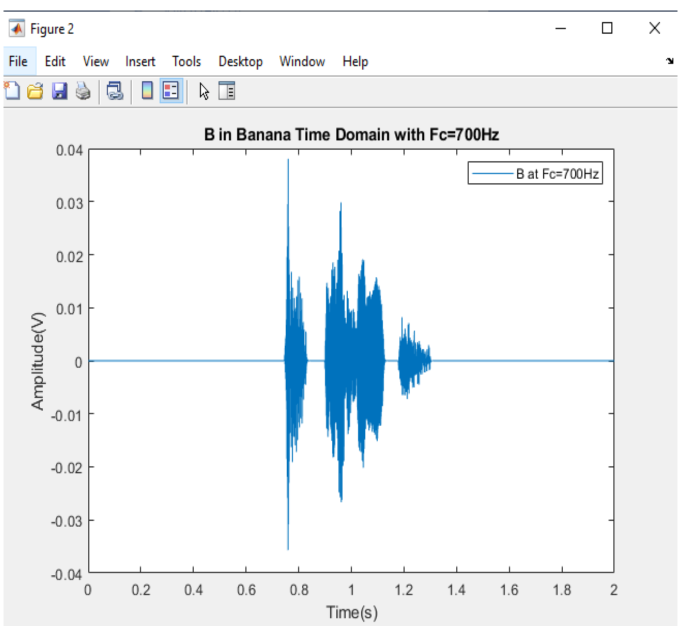

Figure 18 shows the time domain for letter B with Fc=700Hz

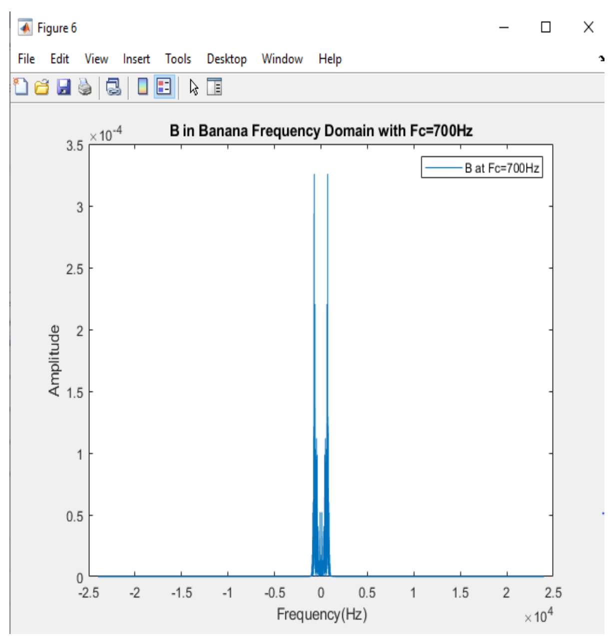

Figure 17 shows the frequency domain for letter B with Fc=700Hz

The letter D

- Original In Time and frequency Domain

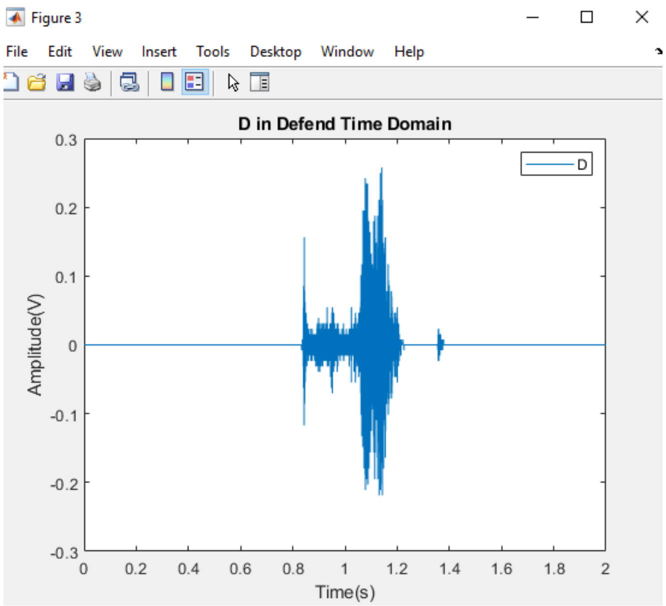

Figure 20 shows the time domain for letter D

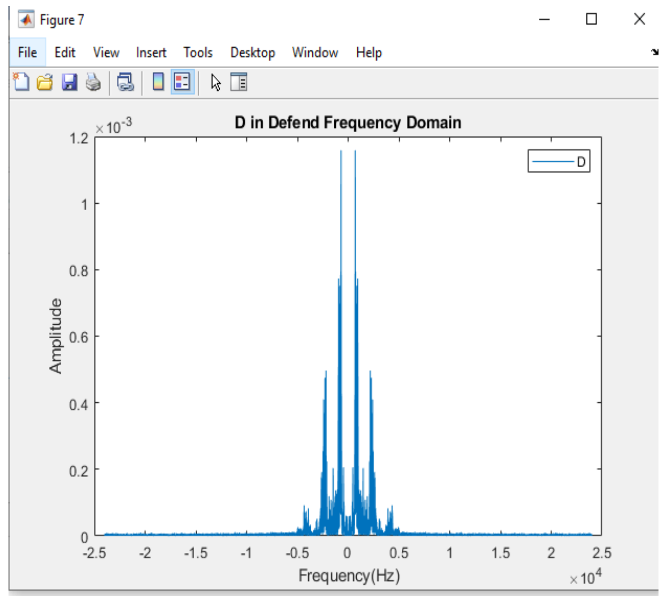

Figure 19 shows the frequency domain for letter D

- With Cutoff Frequency =700Hz In Time and frequency Domain

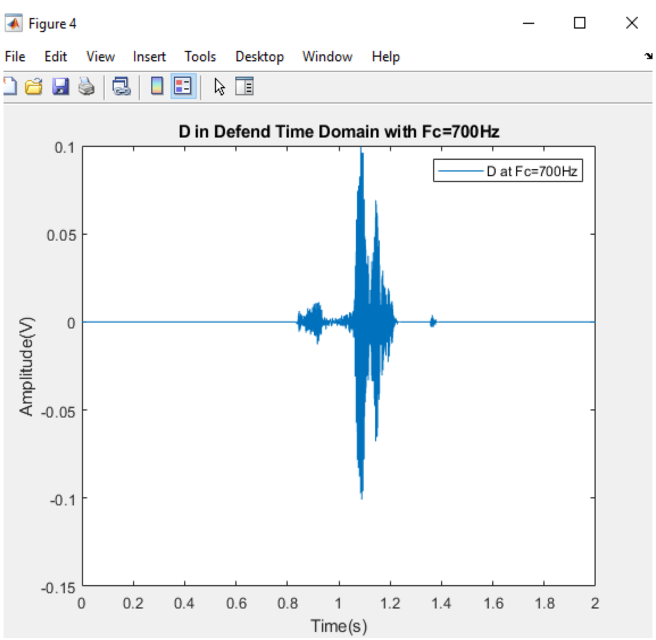

Figure 22 shows the time domain for letter D with Fc=700Hz

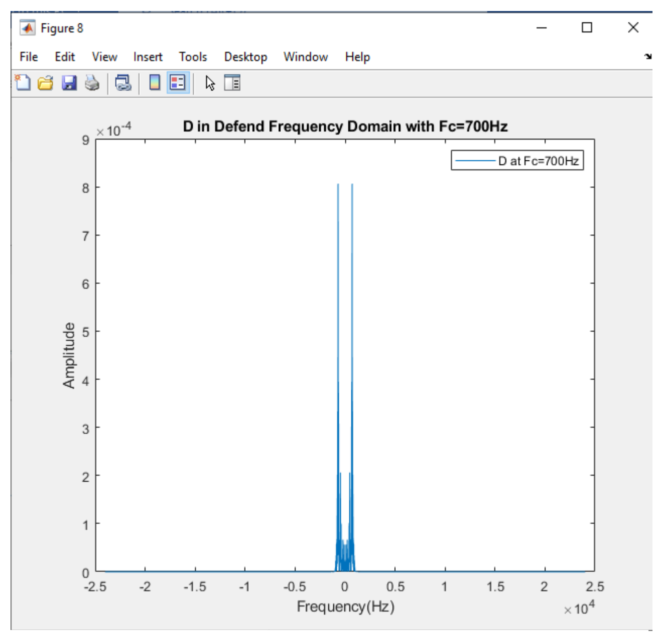

Figure 21 shows the frequency domain for letter D with Fc=700Hz

The letters b and d appear unrecognizable at cut off frequency= 700 Hz. So, we can say the cut of frequency of the plosives or stops is about 700 Hz.

The letter M

- Original In Time and frequency Domain

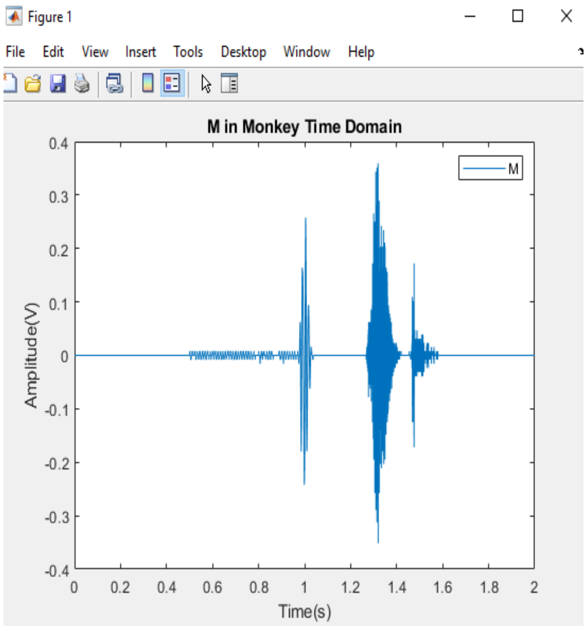

Figure 24 shows the time domain for letter M

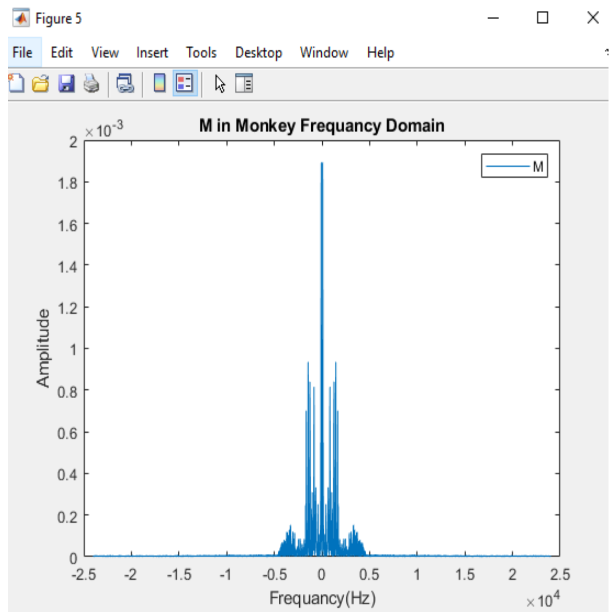

Figure 23 shows the frequency domain for letter M

- With Cutoff Frequency =1000Hz In Time and frequency Domain

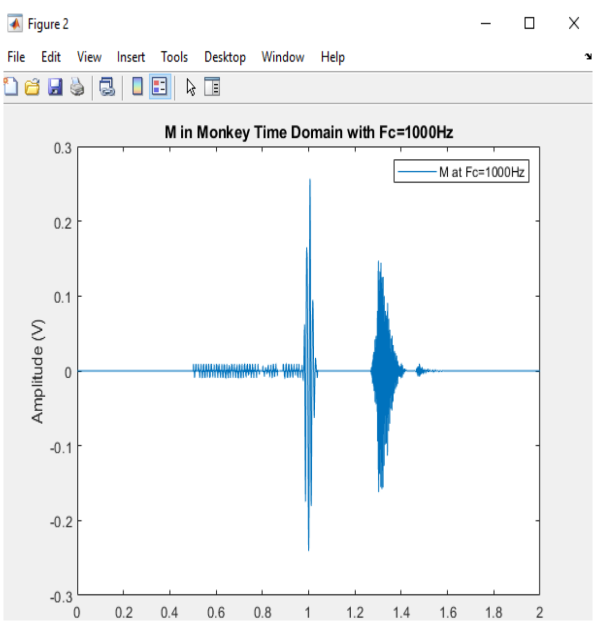

Figure 26 shows the time domain for letter M at Fc=1000Hz

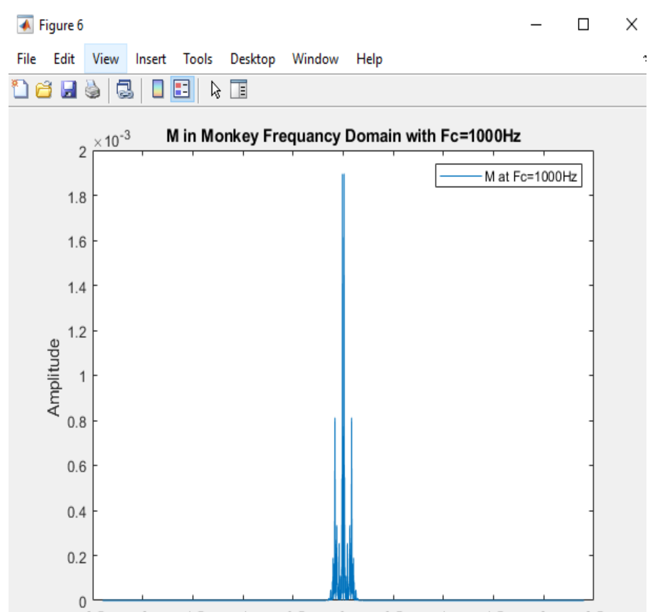

Figure 25 shows the frequency domain for letter M at Fc=1000Hz

The Letter N

- Original Time and frequency Domain

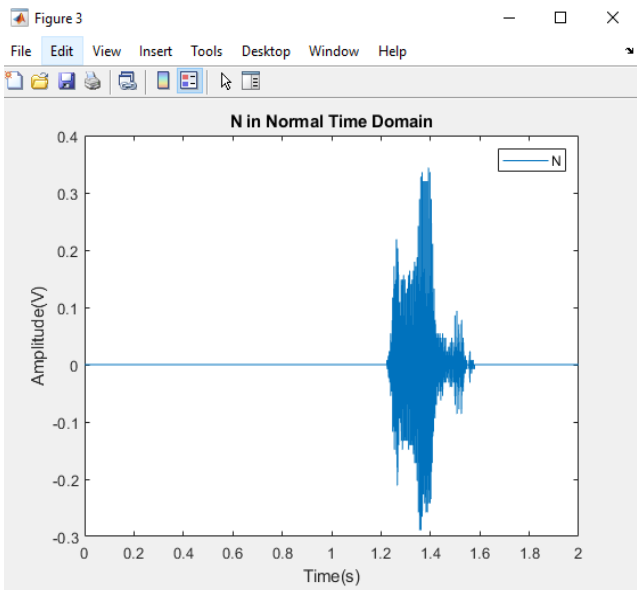

Figure 27 shows the time domain for letter N

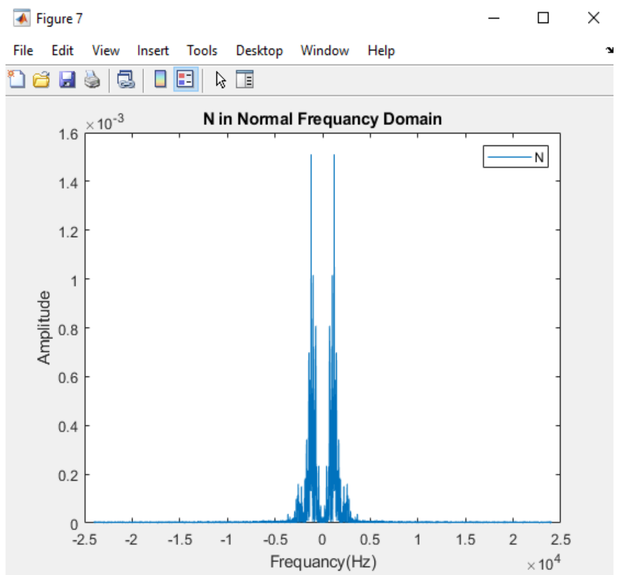

Figure 28 shows the frequency domain for letter N

- With Cutoff Frequency =1000Hz In Time and frequency Domain

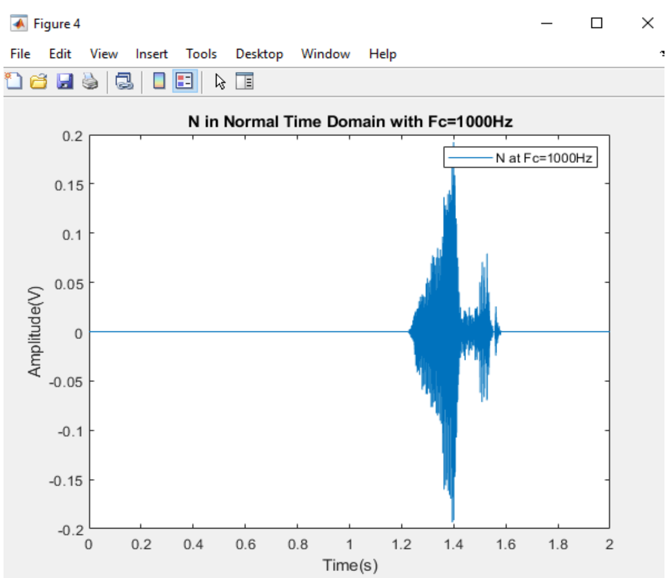

Figure 29 shows the time domain for letter N at fc=1000Hz

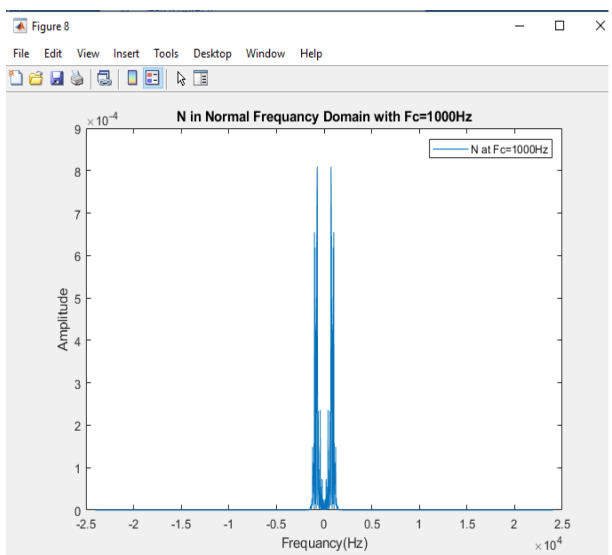

Figure 30 shows the frequency domain for letter N at fc=1000Hz

The letters m and n appear unrecognizable at cut off frequency= 1000 Hz. So, we can say the cut of frequency of the nasals is about 1000 Hz.

Double Side Band Large Carrier Modulation

- In Time Domain

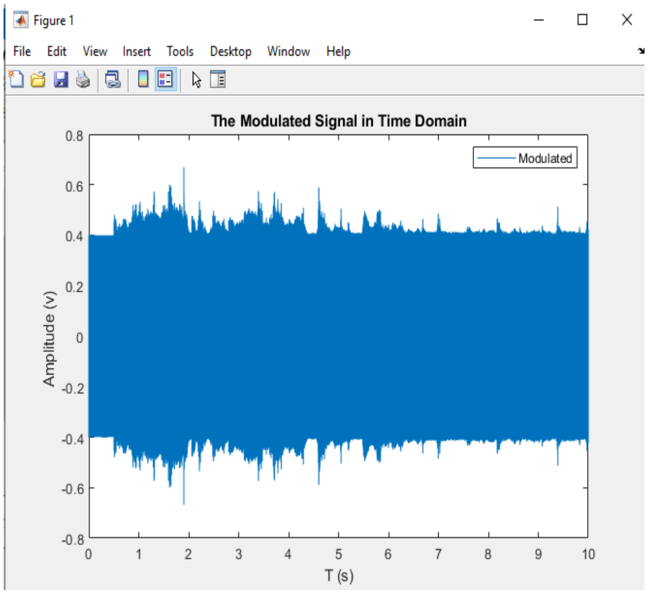

Figure 32 shows DSB-LC Modulated Signal in Time Domain

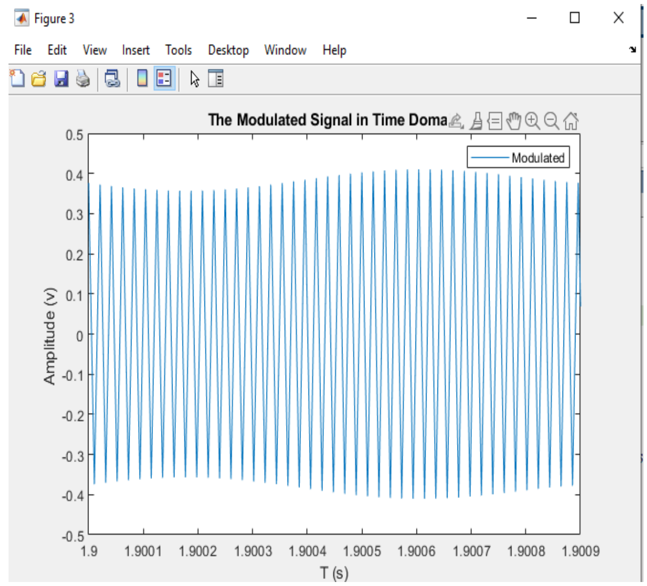

Figure 31 shows part of DSB-LC Modulated Signal

- In Frequency Domain

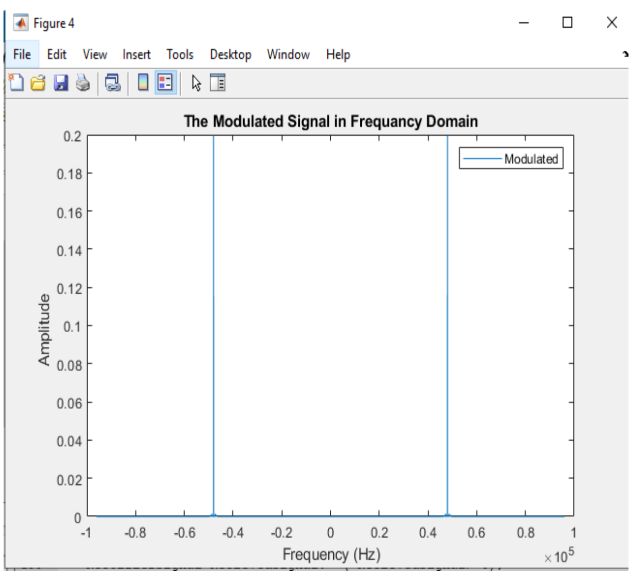

Figure 34 shows DSB-LC Modulated Signal in Frequency Domain

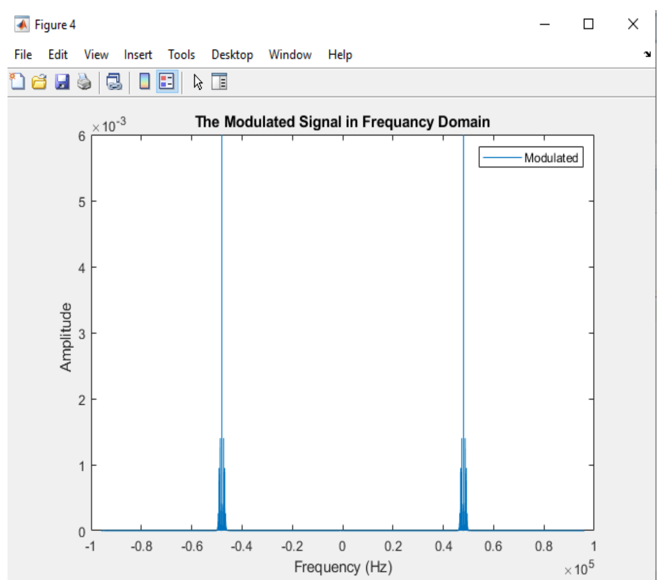

Figure 33 shows Part of DSB-LC Modulated Signal

The Demodulated Signal

- In Time domain

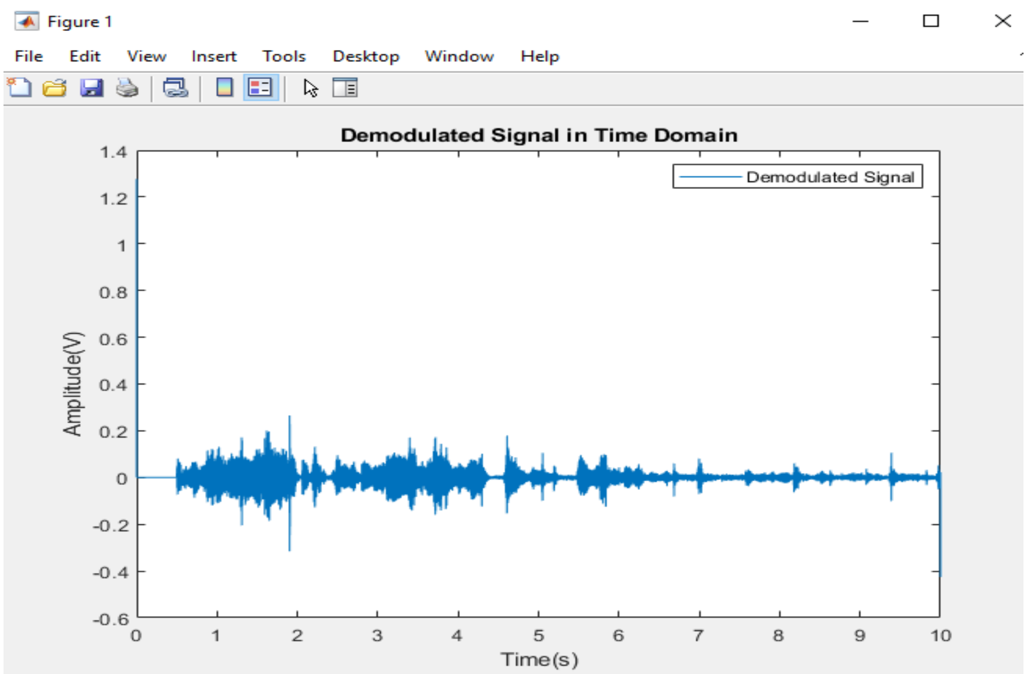

Figure 35 shows DSB-LC Demodulated Signal in Time Domain

- In Frequency Domain

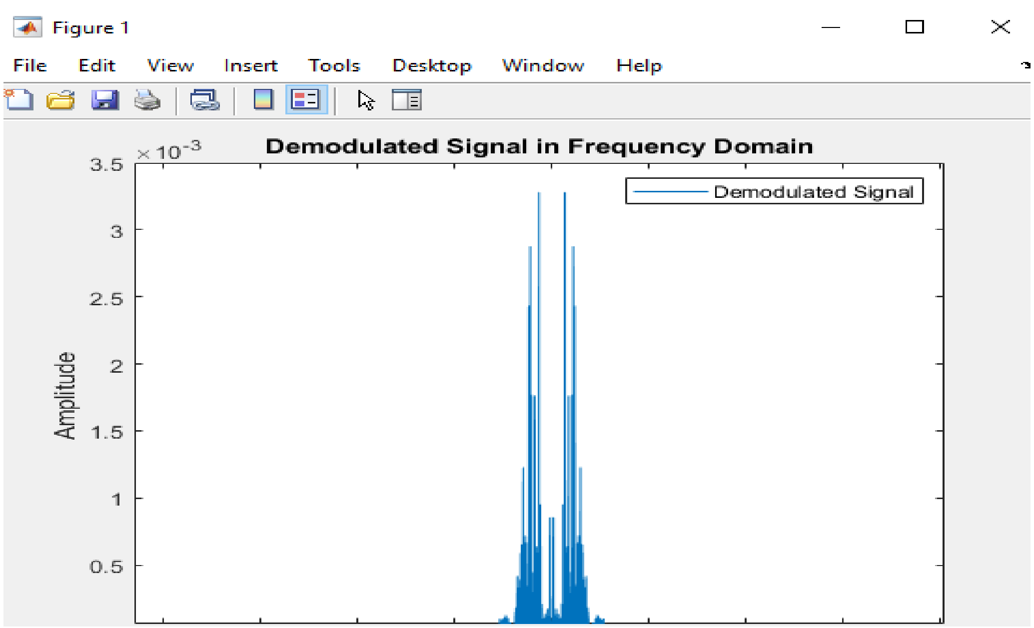

Figure 36 shows DSB-LC Modulated Signal in Frequency Domain

Part II

Double Side Band Supersede Carrier DSB-SC

- Modulated Signal in Time Domain

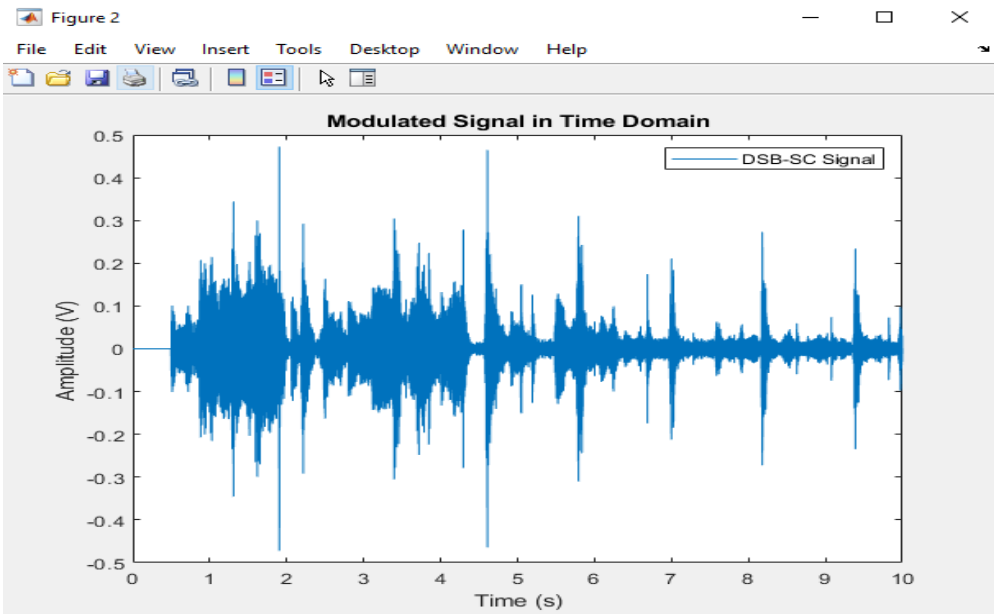

Figure 37 shows DSB-SC Modulated Signal in Time Domain

- Modulated Signal in Frequency Domain

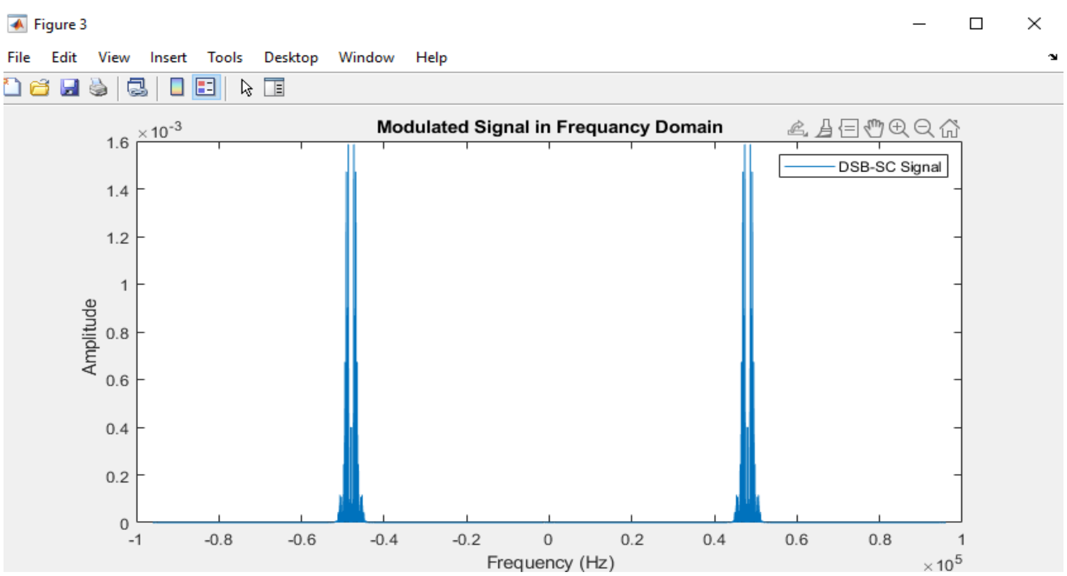

Figure 38 shows DSB-SC Modulated Signal in Frequency Domain

Demodulation using the coherent Detector

- Demodulated Signal In Time Domain

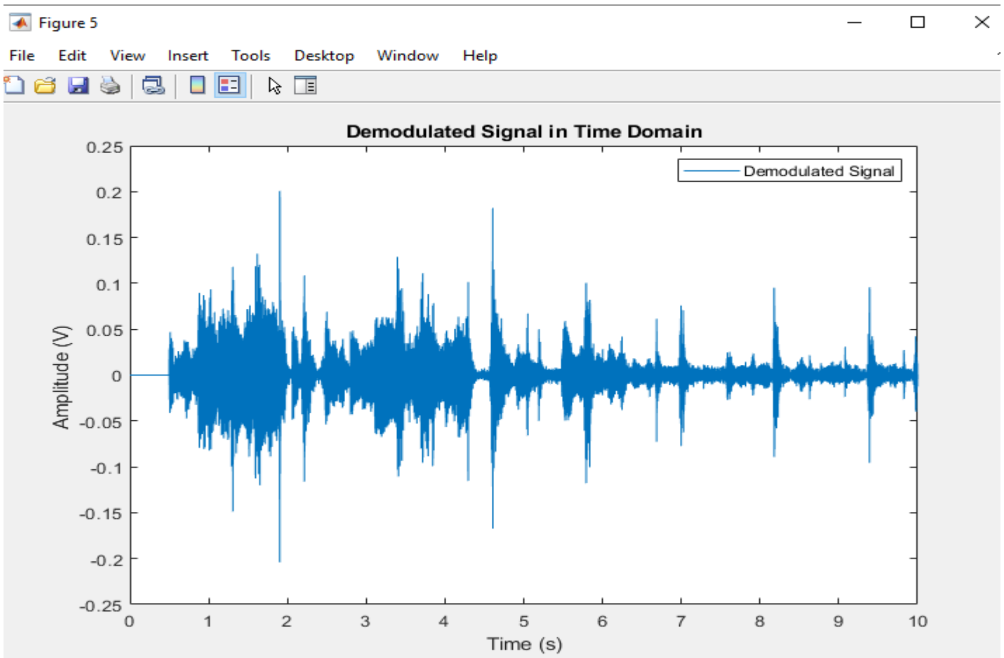

Figure 39 shows DSB-SC Demodulated Signal in Time Domain

- Demodulated Signal In Frequency Domain

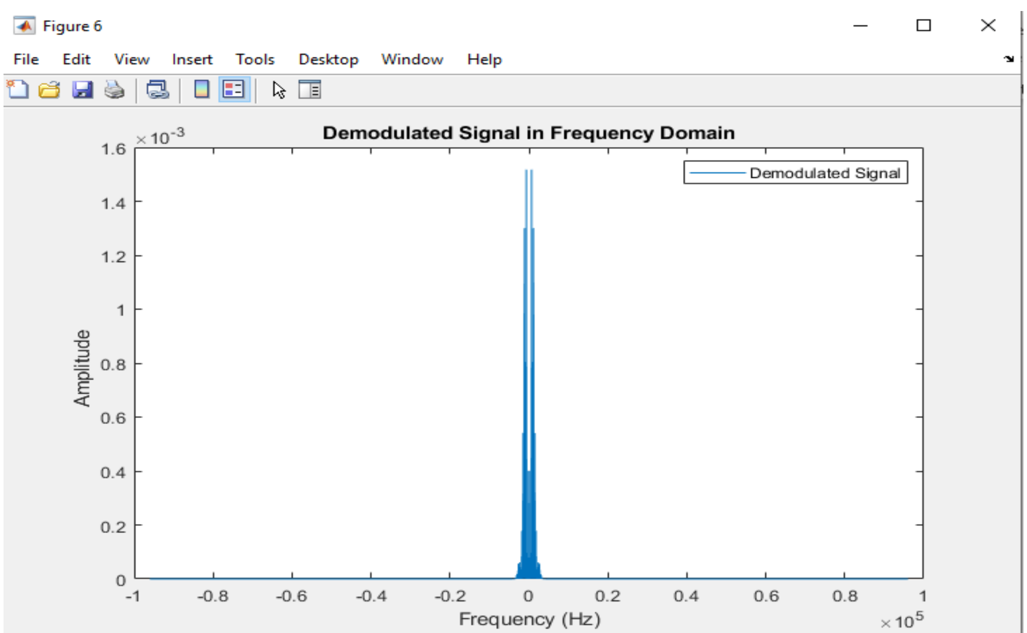

Figure 40 shows DSB-SC Demodulated Signal in Frequency Domain

Demodulated Signal with frequency offset =7000 Hz

- Demodulated Signal In Time Domain

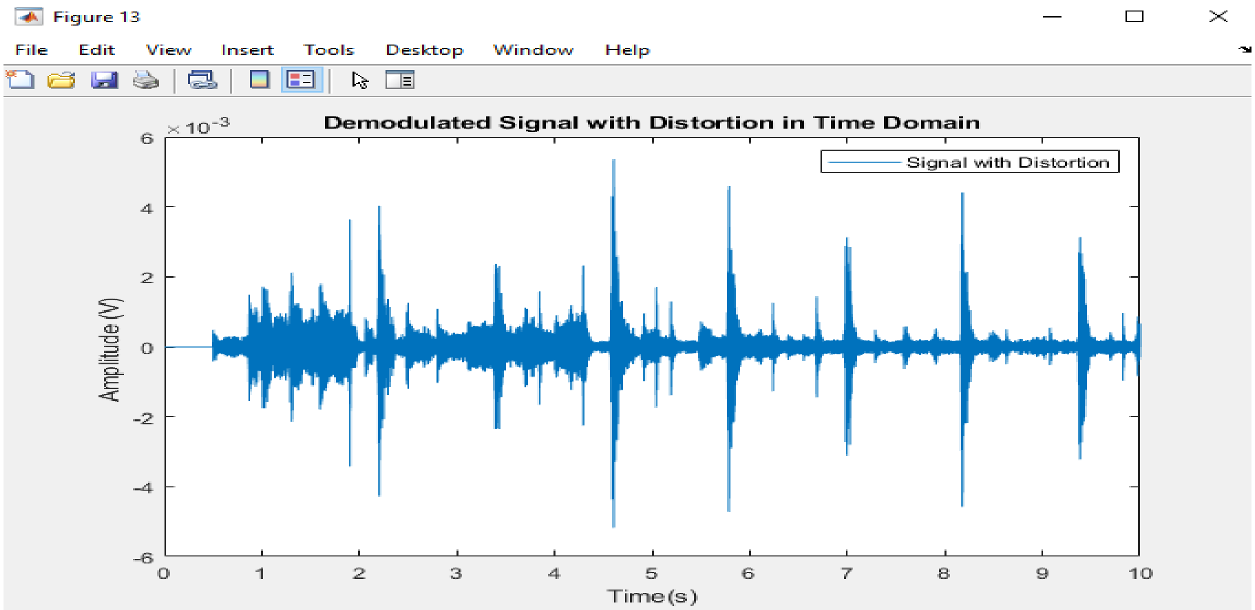

Figure 41 shows DSB-SC Distortional Signal in Time Domain

- Demodulated Signal In Frequency Domain

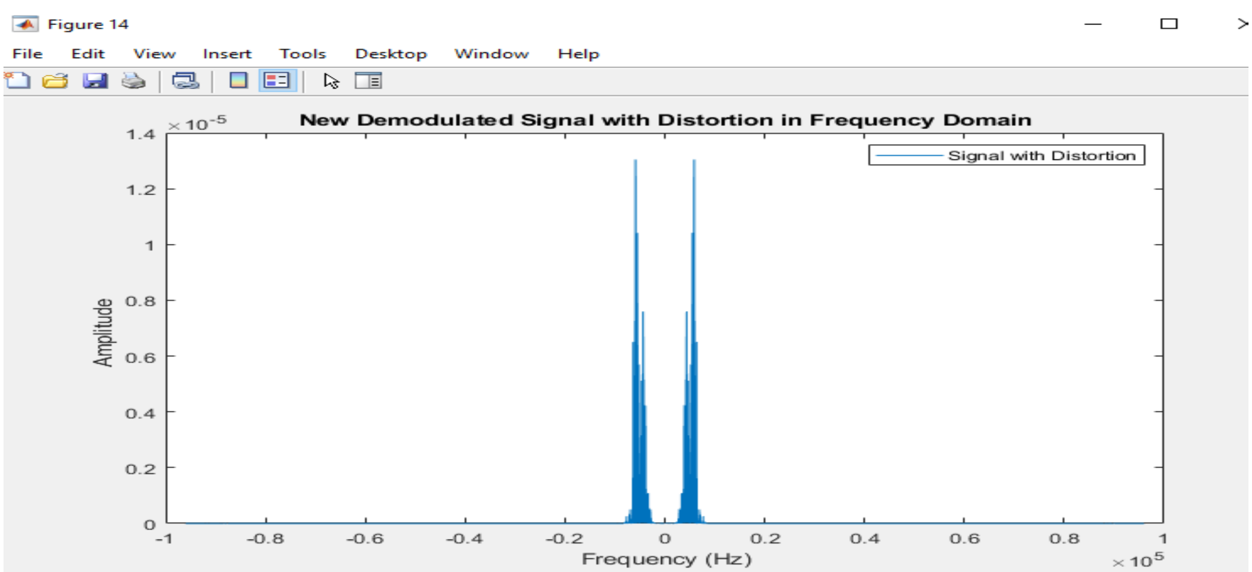

Figure 42 shows DSB-SC Distortional Signal in Frequency Domain

As long as the frequency offset increases, the message disappears. As shown in the time domain the amplitude in demodulated with distortion signal is tiny compered to the original message. So, Signal attenuation occurs.

Single Side Band Modulation

- Modulated Signal In Time Domain

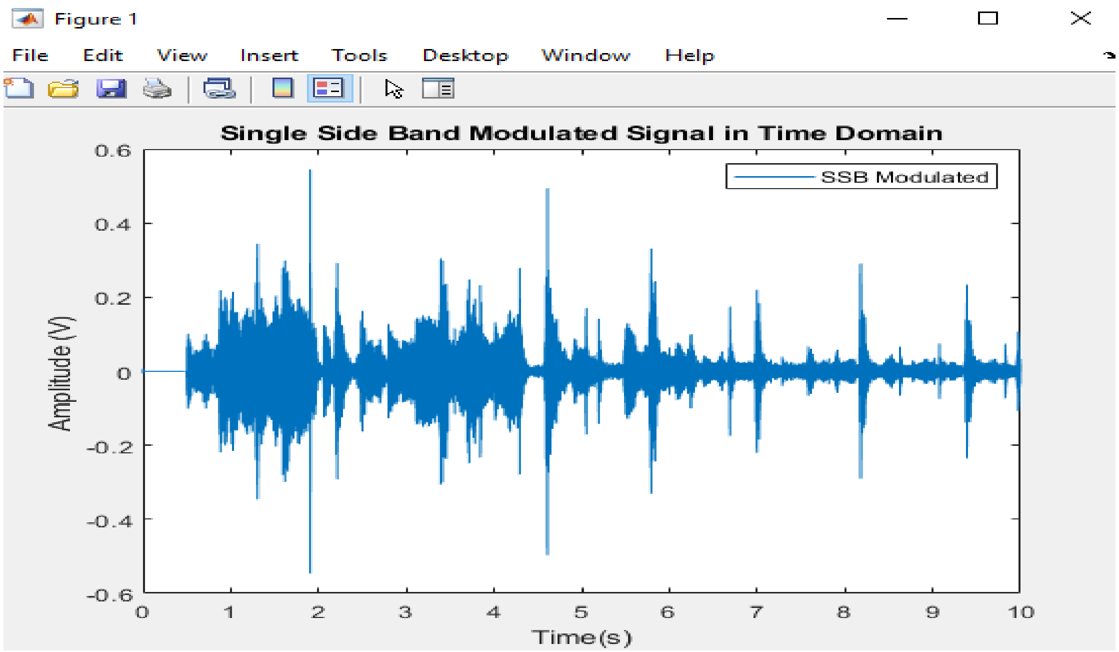

Figure 43 shows SSB Modulated Signall in Time Domain

- Modulated Signal In Frequency Domain

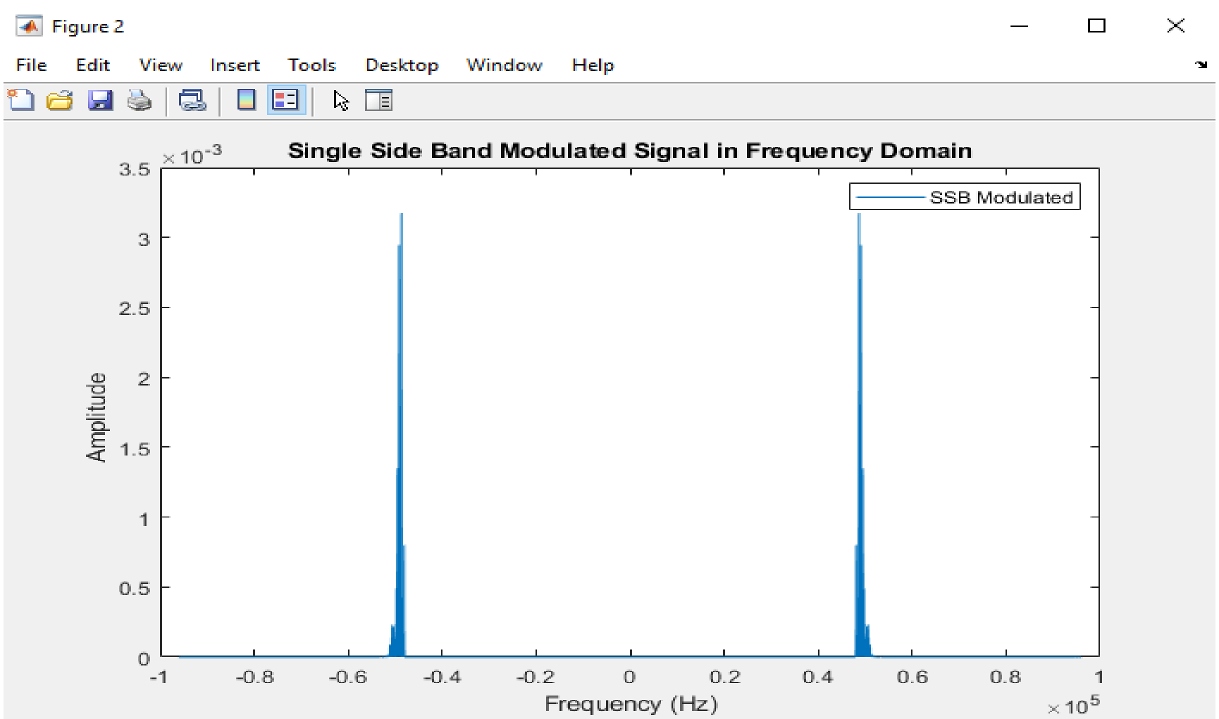

Figure 44 shows SSB Modulated Signal in Frequency Domain

Single Side Band Demodulation

- Demodulated Signal In Time Domain

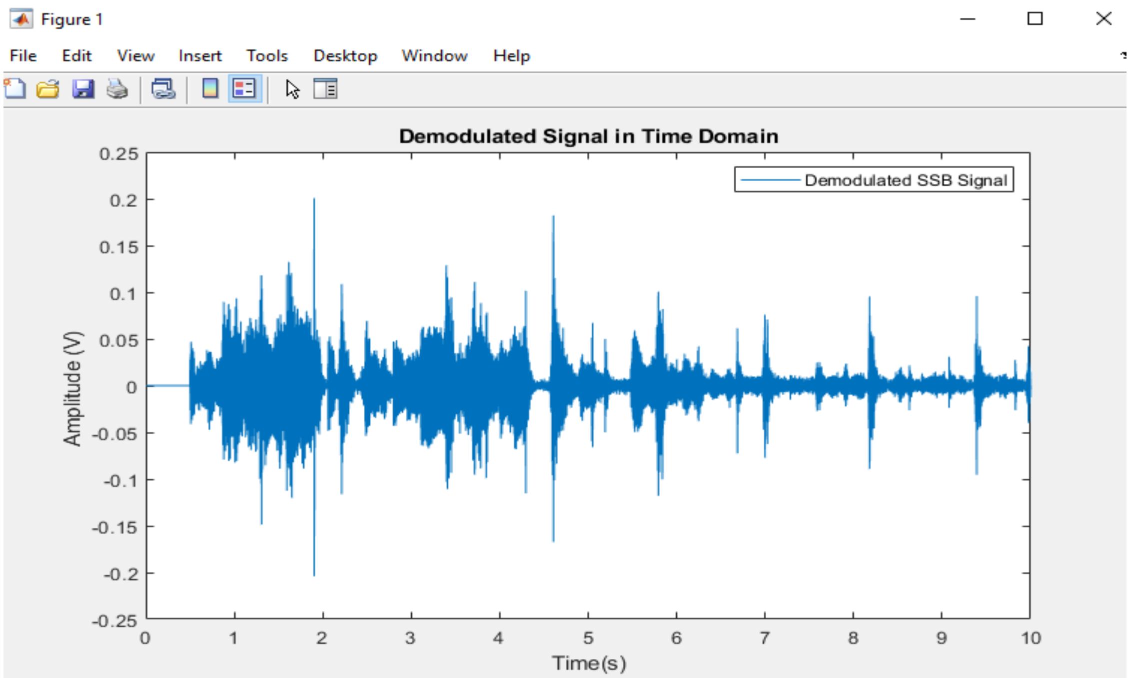

Figure 45 shows SSB Demodulated Signal in Time Domain

- Demodulated Signal In Frequency Domain

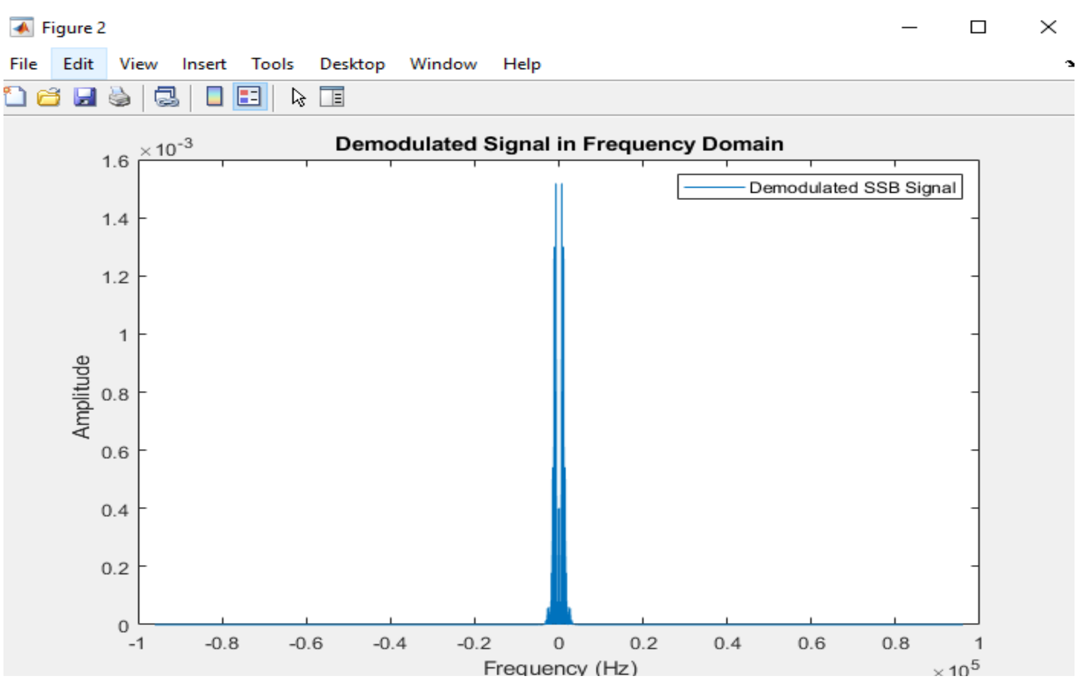

Figure 46 shows SSB Demodulated Signal in Frequency Domain

Demodulated Signal with Frequency Offset = 600 Hz

- Demodulated Signal In Time Domain

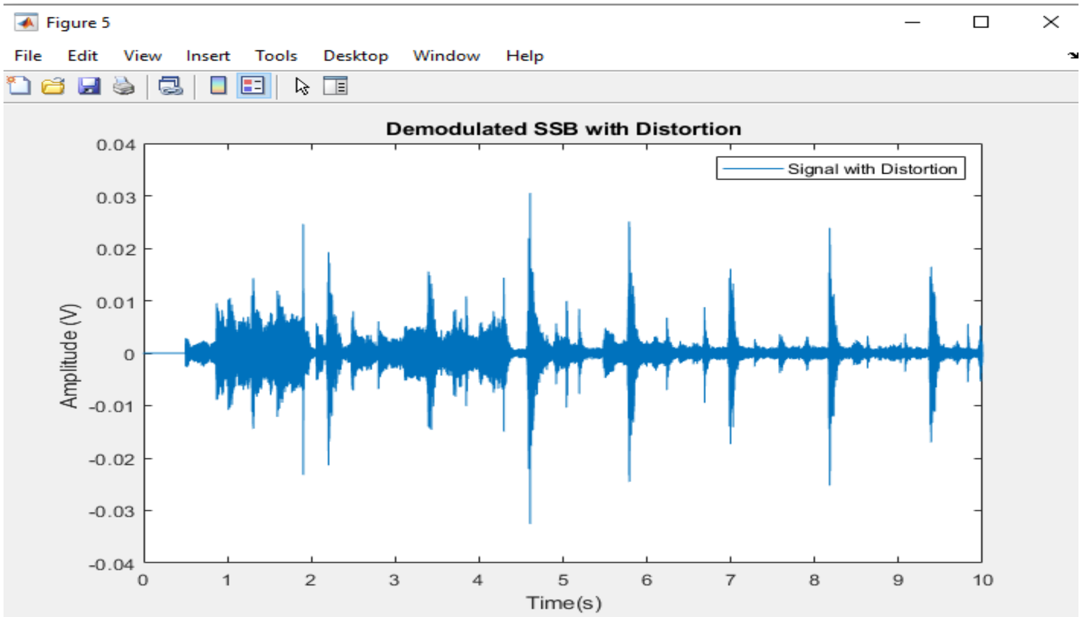

Figure 47 SSB shows Distortional Signal in Time Domain

- Demodulated Signal In Frequency Domain

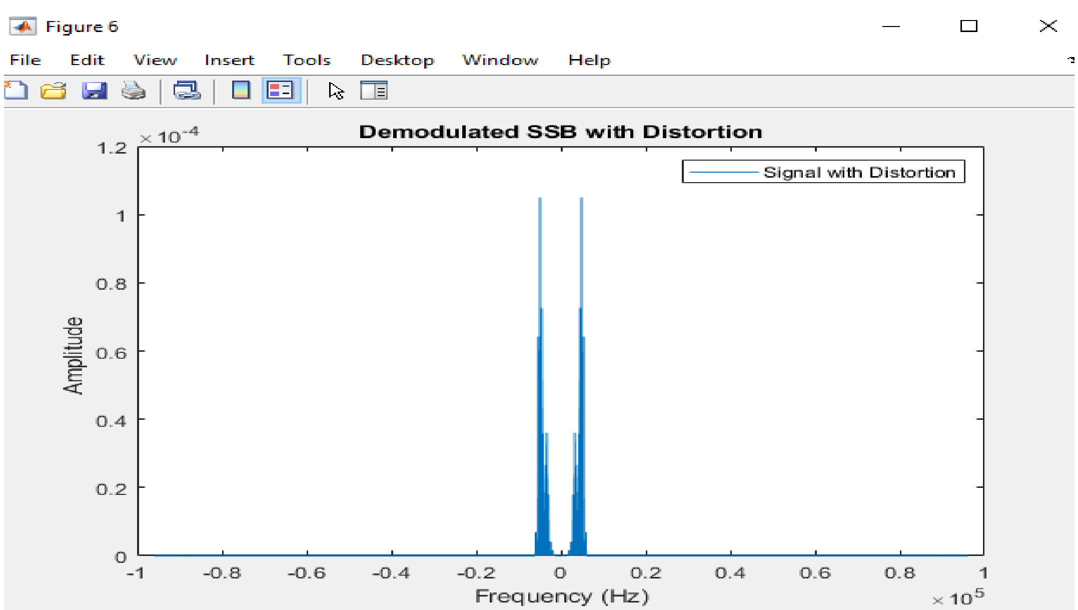

Figure 48 shows SSB Distortional Signal in Frequency Domain

Hard distortion occurs when increasing the frequency distortion. At low frequencies, some attenuation occurs at the voice. But while the delta frequency increases, the signal become unrecognizable. It appears as a cross talk or another signal.

Part III

FM Modulation

➢ **With frequency deviation=5**

- Modulated Signal In Time Domain

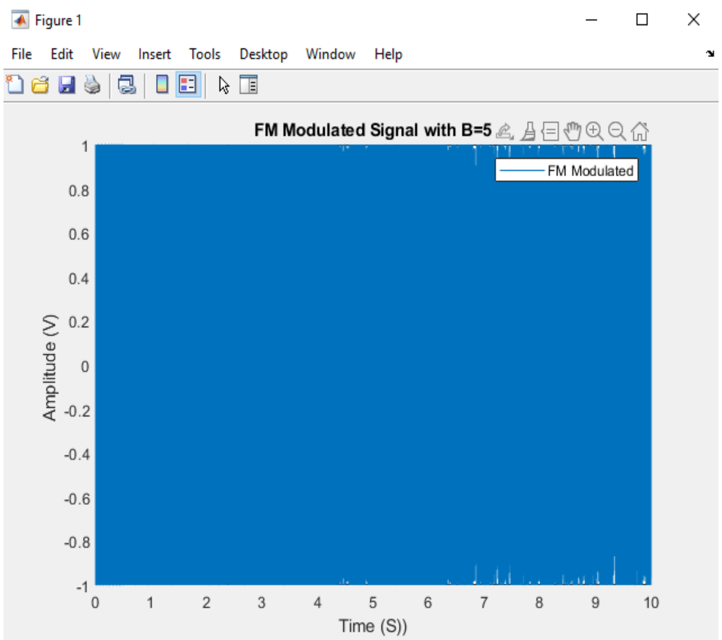

Figure 50 shows FM Modulated Signal in time domain with beta=5

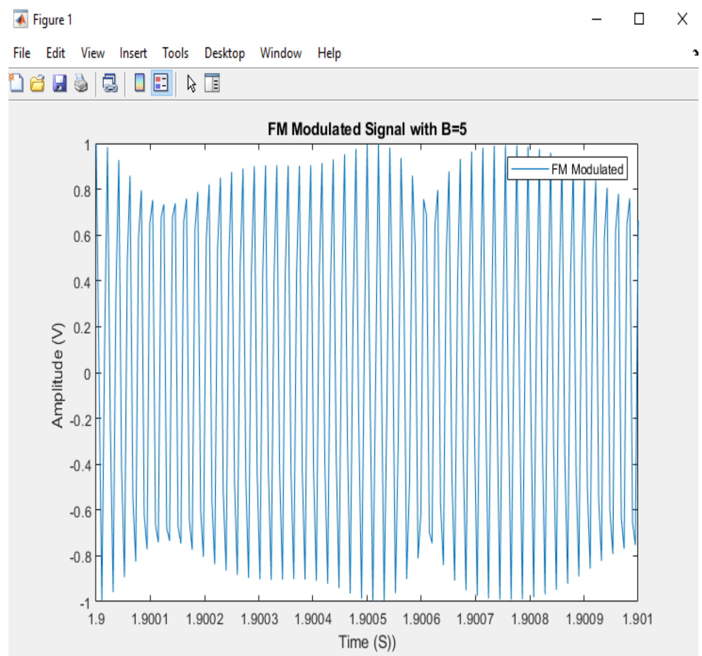

Figure 49 shows Part of FM Modulated Signal with beta=5

- Modulated Signal In Frequency Domain

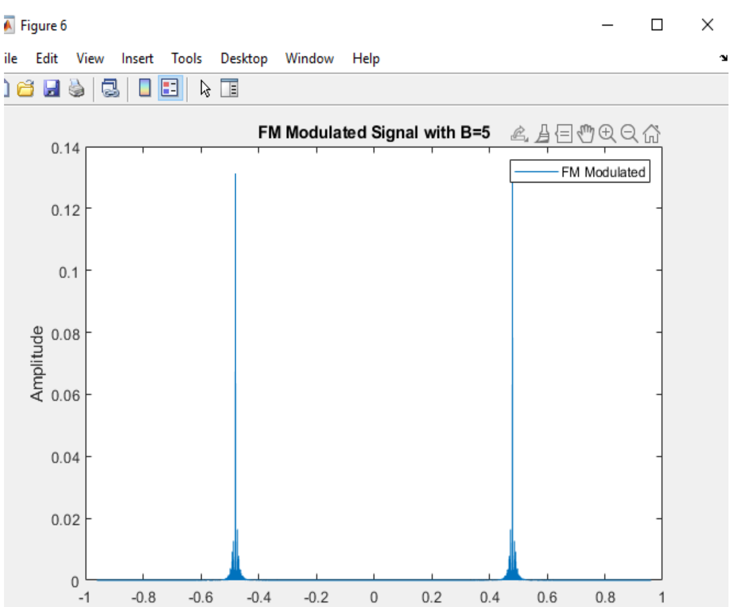

Figure 52 shows FM Modulated Signal in Frequency Domain with beta=5

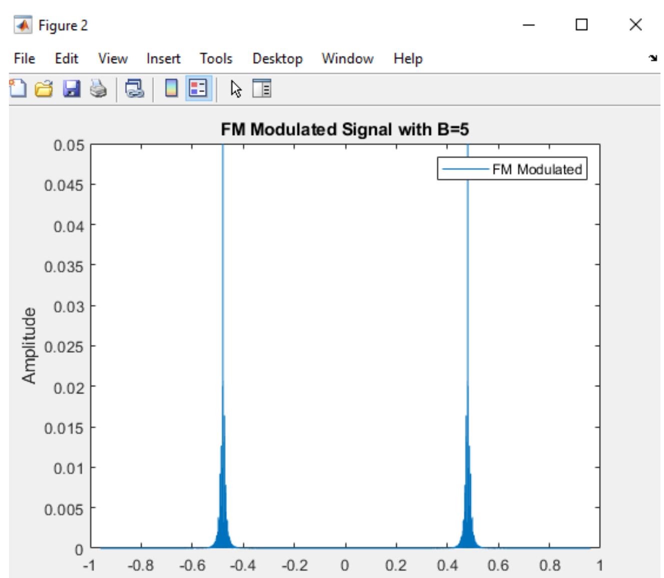

Figure 51 shows Part of FM Modulated Signal with beta=5

➢ With frequency deviation=3

- Modulated Signal In Time Domain

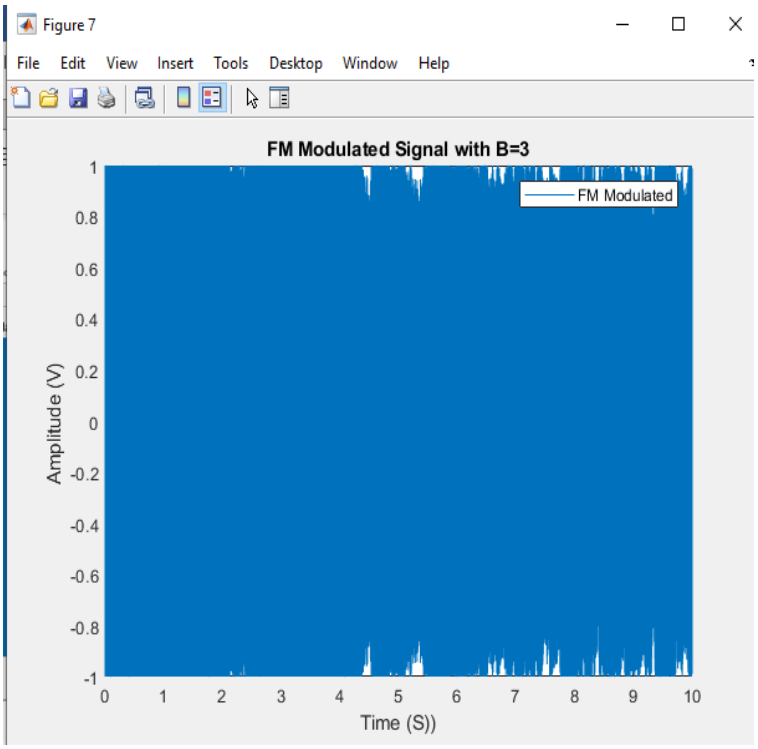

Figure 54 shows FM Modulated Signal in time Domain with beta=3

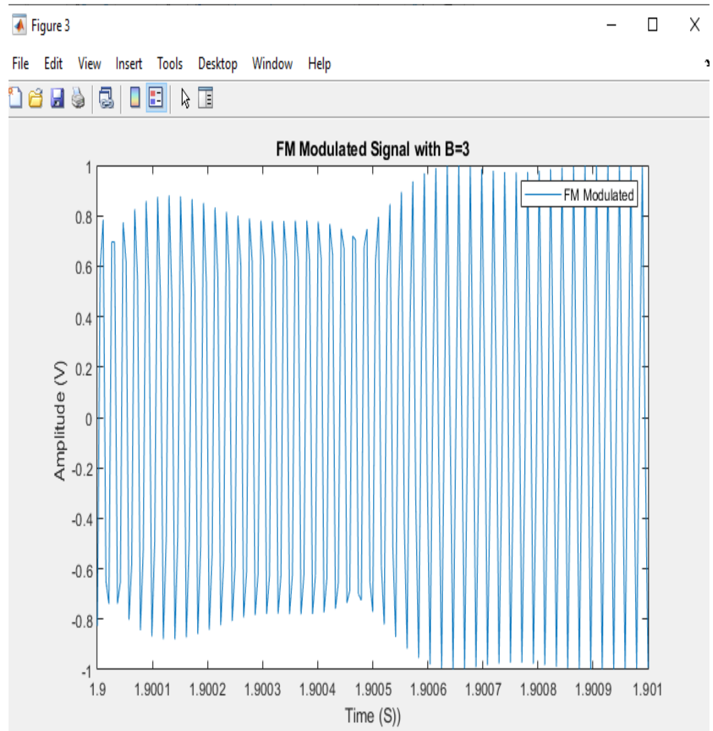

Figure 53 shows Part of FM Modulated Signal with beta=3

- Modulated Signal In Frequency Domain

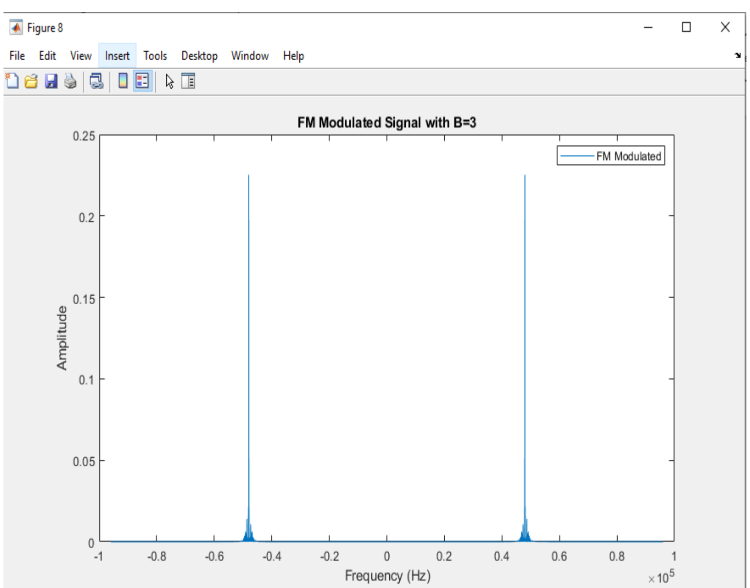

Figure 55 shows Modulated Signal in frequency Domain with beta=3

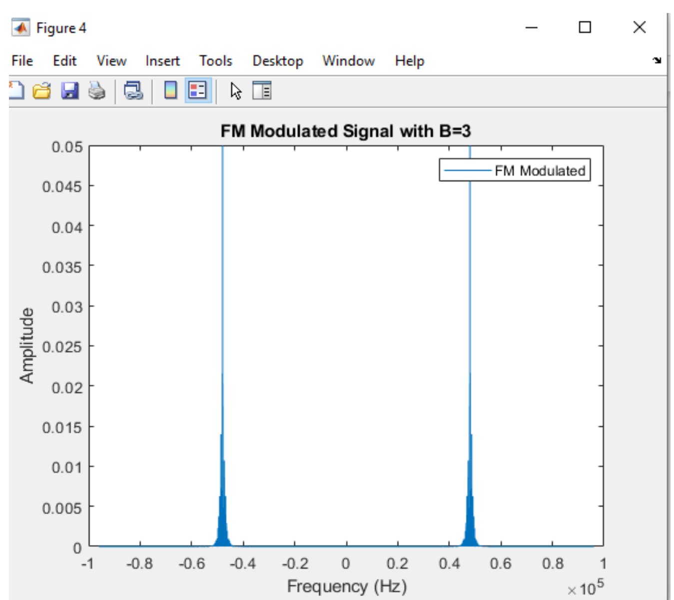

Figure 56 shows Part of FM Modulated Signal with beta=3

The Bandwidth of the FM modulated Signal

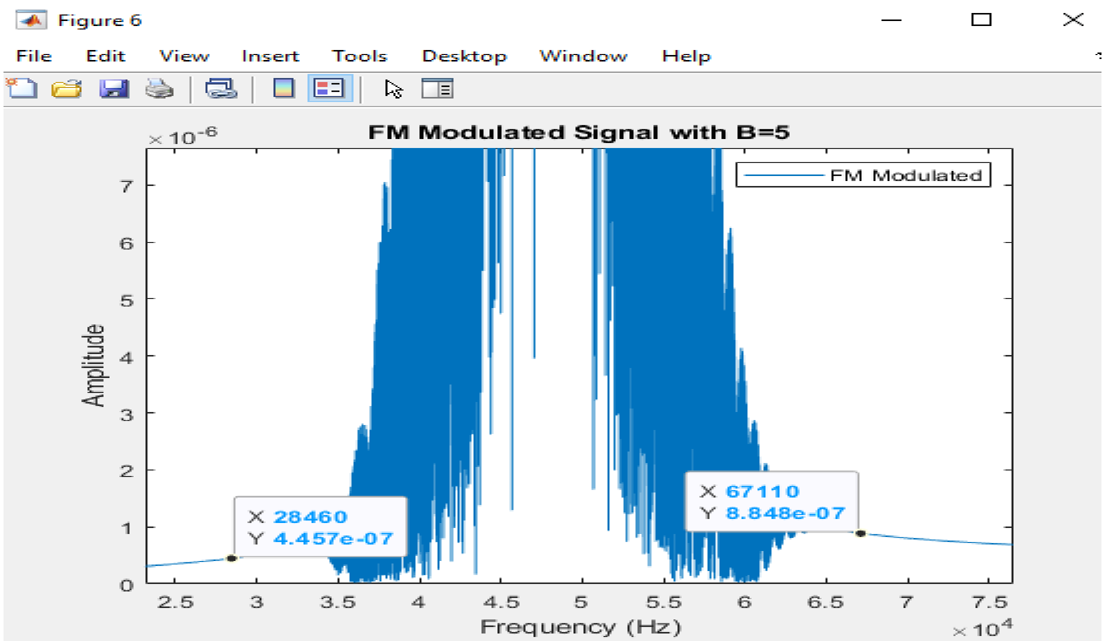

Figure 57 shows Bandwidth of FM Modulated Signal

From the graph

The Bandwidth = 67110-28460=38650 Hz

Theoretically:

The Bandwidth= 2*Fm*(1+beta) = 2*3400*(1+5) = 40800 Hz

FM Demodulation

➢ With frequency deviation=5

- Demodulated Signal In Time Domain and Frequency Domain

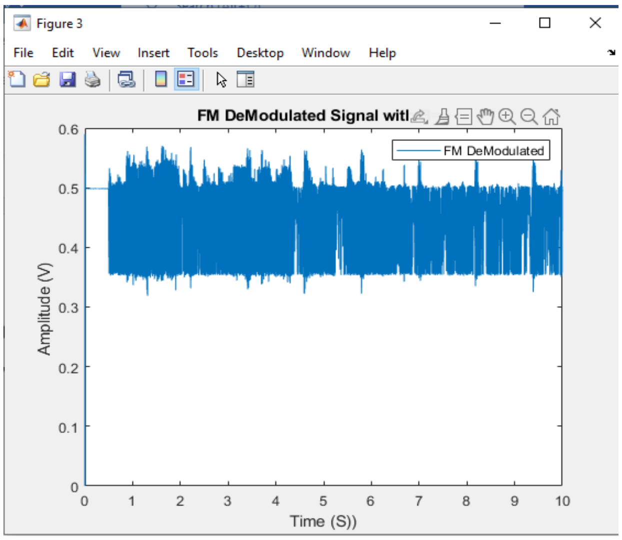

Figure 58 shows the FM Demodulated Signal in Time Domain with b=5

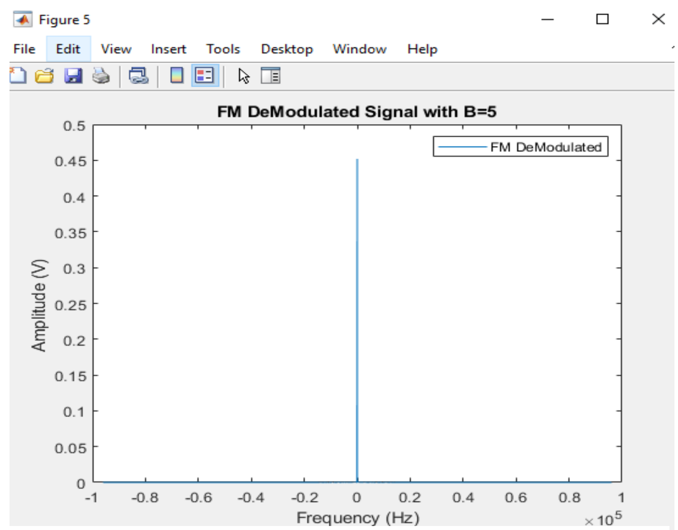

Figure 59 shows the FM Demodulated Signal in Frequency Domain with b=3

➢ With frequency deviation=3

- Demodulated Signal In Time Domain and Frequency Domain

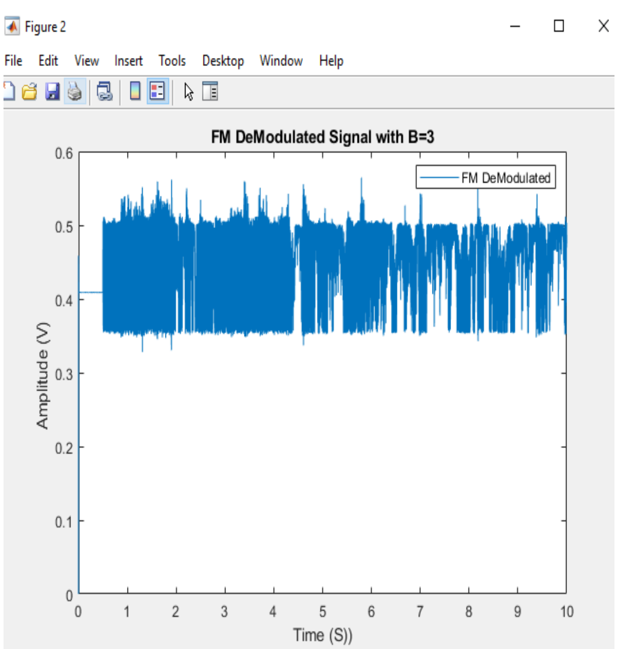

Figure 61 shows the FM Demodulated Signal in Time Domain with b=3

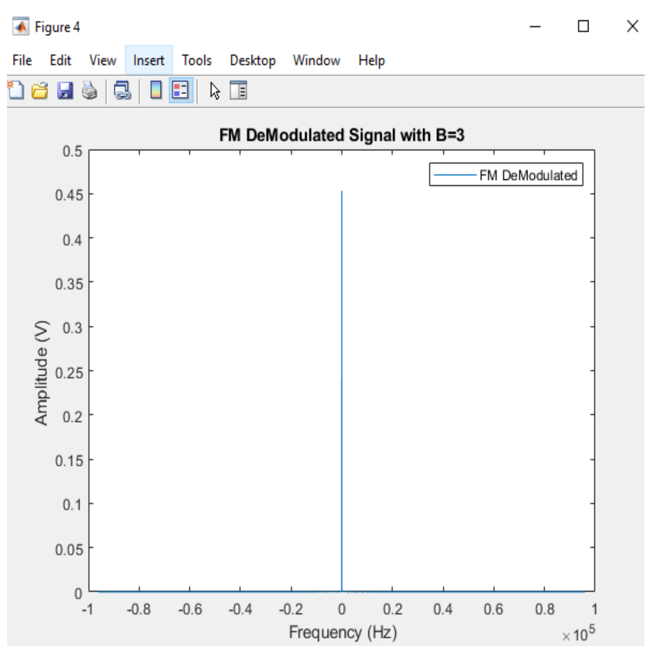

Figure 60 shows the FM Demodulated Signal in Frequency Domain with b=3

Single Tone Modulation With B=5

➤ In Time Domain

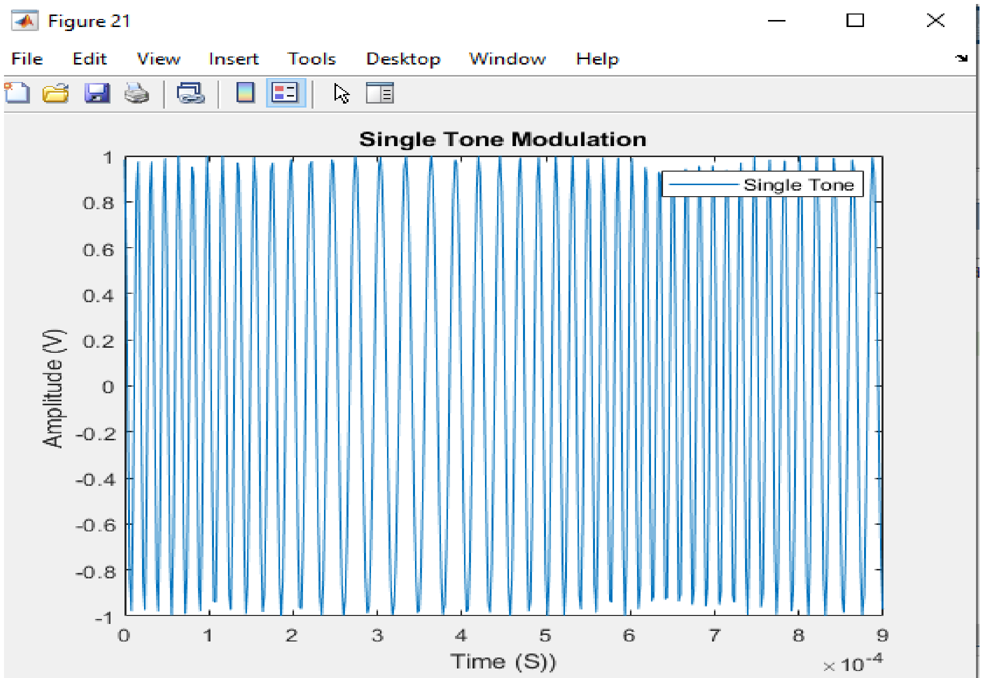

Figure 62 shows FM Modulated Single Tone in Time Domain

➤ In frequency Domain

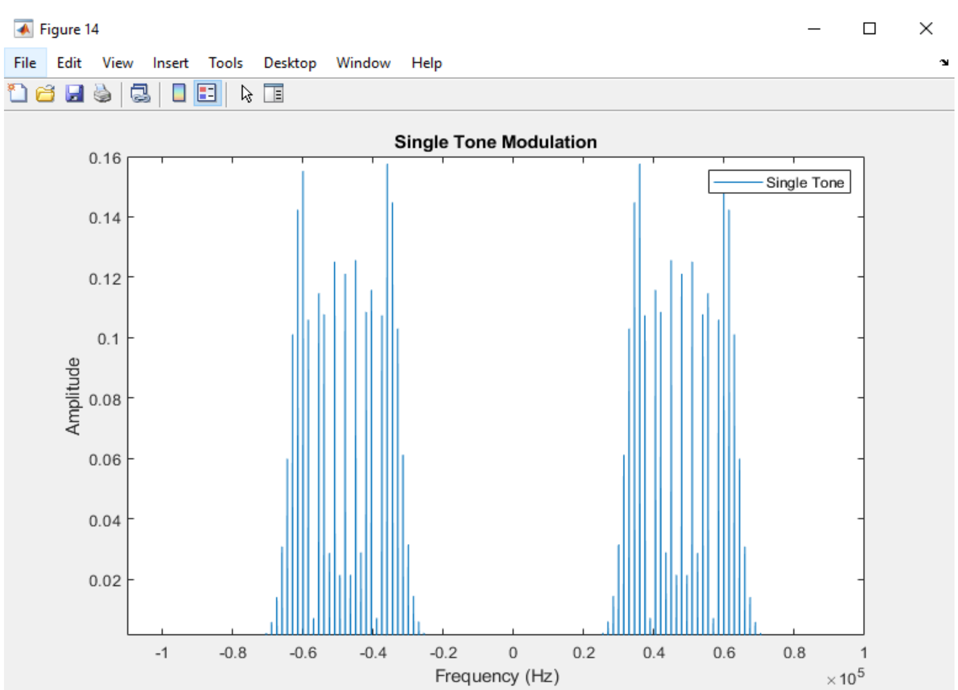

Figure 63 shows FM Modulated Single Tone in Frequency Domain

Single Tone Modulation with B=3

- In Time Domain

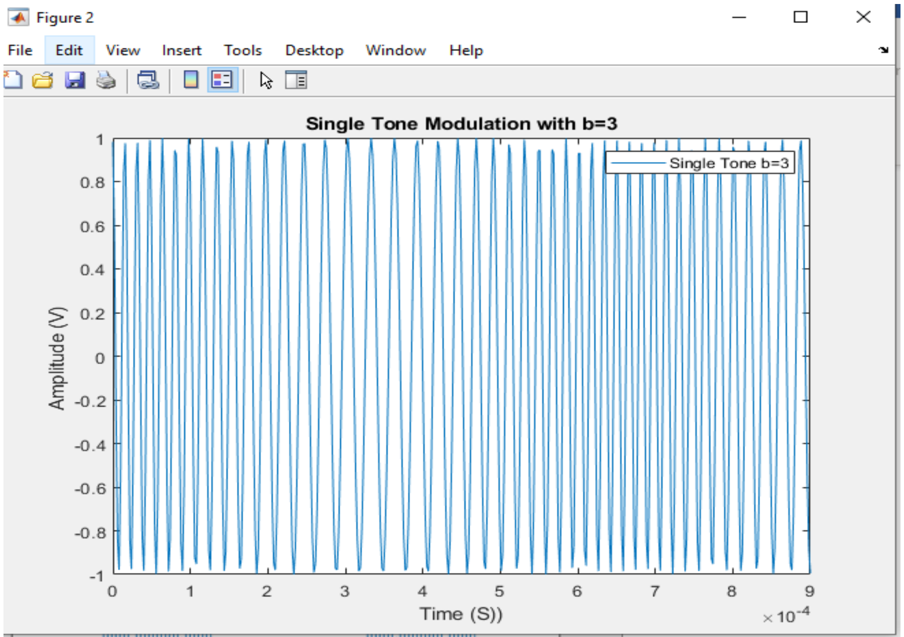

Figure 64 shows FM Modulated Single Tone in Time Domain

- In Frequency Domain

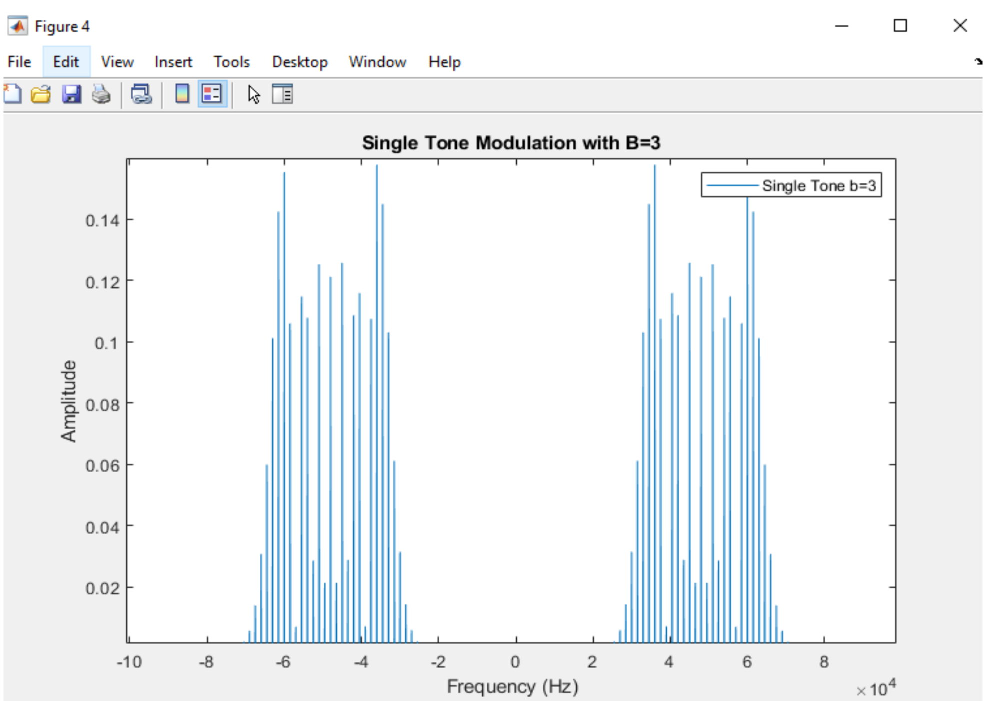

Figure 65 shows FM Modulated Single Tone in Frequency Domain

The Bandwidth of the single tone at beta = 3

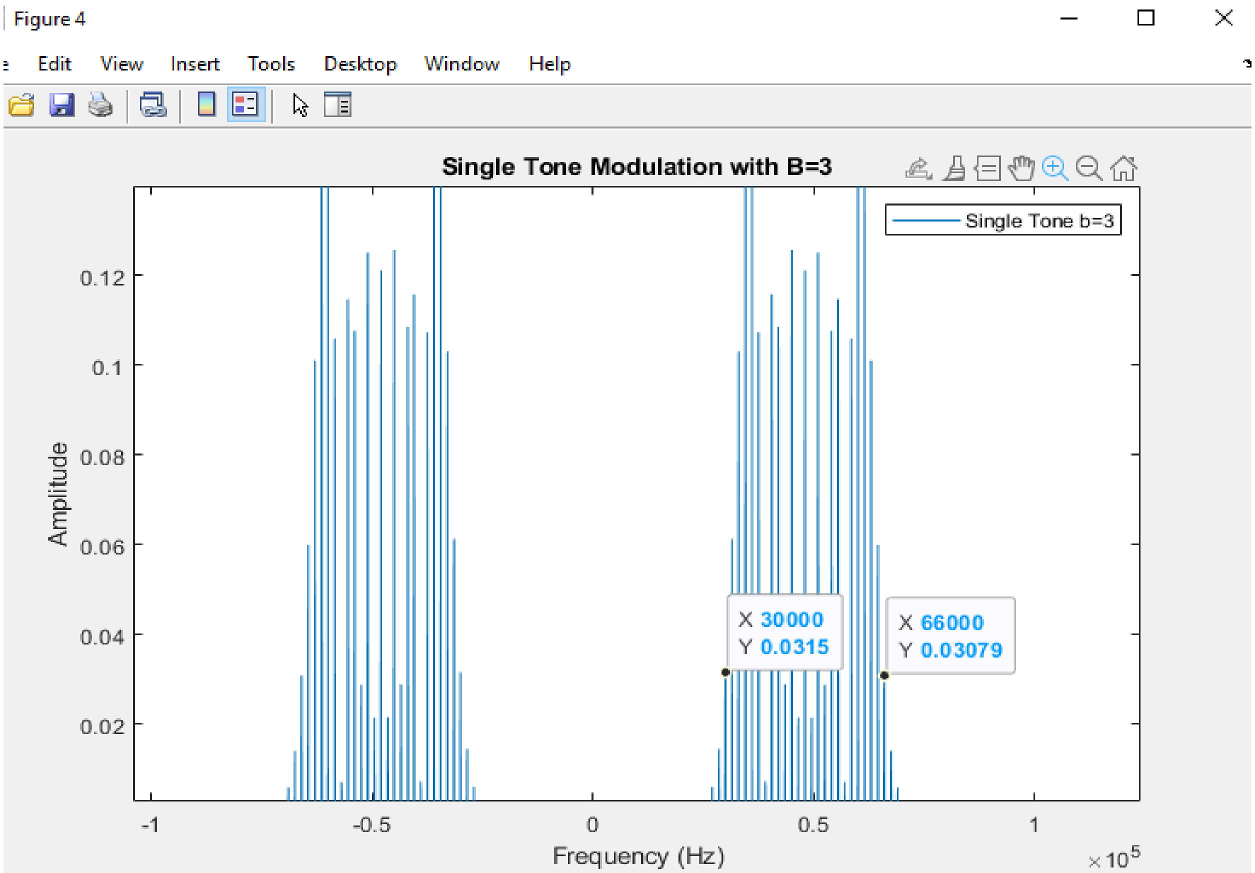

Figure 66 shows the bandwidth of the single tone

From the graph

The Bandwidth = 66000-30000=36000 Hz

Theoretically:

The Bandwidth= 2*Fm*(1+beta) = 2*3000*(1+3) = 24000 Hz

The bandwidth in the graph id bigger than the theoretical.

Part IV

Add Gaussian noise to the FM signal

When adding more noise to the FM modulated signal, Signal to noise ratio (SNR o) output decreases. As at small values of SNRin, the No becomes large. According to the relation between the SNRo and No, when the No increases, the SNRo decreases. So, the demodulated signal becomes different from the message signal. And at large values of SNRin, the demodulated signal becomes similar to the message signal as the SNRo increases.

And at different levels of deviation ratio and same SNR in, the effect of the noise on the signal varies according to the different in the bandwidth. As the bandwidth of the modulated FM signals = 2*Fm*(1+ deviation ratio). So, when the deviation ratio increases, the bandwidth increases. According to the relation between the SNRo and the deviation ratio when the deviation ratio increases, the SNRo increases.

$$\boldsymbol{SNR_0 = 3\beta^2 \frac{P_m}{m_p^2} SNR_0]_{Baseband}}$$

The Beta Threshold

At SNRBB=7 db, the SNRO = 15.2673db, the B threshold= 16.0206 db, deviation ration=1,

As the SNR output is smaller than B threshold, these calculations are not correct. The correct solution for the SNR output can be determined from the SNRBB-SNRO curve at this deviation ratio. (beta=7).

At SNRBB=7 db and the deviation ration=1, SNRo = 16.2673 db, THRESHOLD = 16.0206db

So we can say it is the threshold for beta=2